SCIENCE

EDITORIAL COMMITTEE: S. NEWCOMB, Mathematics; R. S. WOODWARD, Mechanics; E. C. PICKERING, Astronomy; T. C. MENDENHALL, Physics; R. H. THURSTON, Engineering; IRA REMSEN, Chemistry; JOSEPH LE CONTE, Geology; W. M. DAVIS, Physiography; HENRY F. OSBORN, Paleontology; W. K. BROOKS, C. HART MERRIAM, Zoology; S. H. SCUDDER, Entomology; C. E. BESSEY, N. L. BRITTON, Botany; C. S. MINOT, Embryology, Histology; H. P. BOWDITCH, Physiology; J. S. BILLINGS, Hygiene; WILLIAM H. WELCH, Pathology; J. MCKEEN CATTELL, Psychology; J. W. POWELL, Anthropology.

FRIDAY, JUNE 29, 1900.

CONTENTS:

The American Association for the Advancement of Science:—

Rhythms and Geologic Time: G. K. GILBERT....1001

The Eighth Group of the Periodic System and some of its Problems: PROFESSOR JAS. LEWIS HOWE 1012

The Royal Society of Canada: DR. H. M. AMI.....1020

Scientific Books:—

Welton on the Logical Bases of Education: PROFESSOR PAUL H. HANUS. *Rice on the Theory and Practice of Interpolation:* PROFESSOR C. L. DOOLITTLE. *Books Received*.....1024

Scientific Journals and Articles.....1027

Discussion and Correspondence:—

The Misuse of Technical Terms: PROFESSOR D. W. HERING. *Correction:* PROFESSOR JACQUES LOEB.....1028

Notes on Electrical Engineering:—

Submarine Telegraphy: W. S. F.....1030

Notes on Engineering:—

'Chilled' Cast-Iron Forts; The 'Air-Splitting' Train: PROFESSOR R. H. THURSTON.....1031

Current Notes on Physiography:—

Topographic Terms; Moraines of South Dakota; Bulletin of the American Bureau of Geography; PROFESSOR W. M. DAVIS.....1032

The Study of Electrical Pressure.....1033

The New York State College of Forestry.....1034

The Forthcoming Meeting of the British Association.1035

Scientific Notes and News.....1036

University and Educational News.....1039

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*RHYTHMS AND GEOLOGIC TIME.**

CUSTOM dictates that in complying with the rule of the Association I shall address you on some subject of a scientific character. But before doing so I may be permitted to pay my personal tribute to the honored and cherished leader of whose loss we are so keenly sensible on this occasion. His kindly personality, the charm which his earnestness and sincerity gave to his conversation, the range of his accomplishment, are inviting themes; but it is perhaps more fitting that I touch this evening on his character as a representative president of this body. The Association holds a peculiar position among our scientific organizations of national or continental extent. Instead of narrowing its meetings by limitations of subject matter or membership, it cultivates the entire field of research and invites the interest and co-operation of all. It is thus not only the integrating body for professional investigators, but the bond of union between these and the great group of cultured men and women—the group from whose ranks the professional guild is recruited, through whom the scientific spirit is chiefly propagated, and through whose interest scientific research receives its financial support. Its aims and form of organization recognize, what pure science

* Read to the American Association for the Advancement of Science at New York, June 26, 1900, as the address of the retiring President.

does not always itself recognize, that pure science is fundamentally the creature and servant of the material needs of mankind, and it thus stands for what might be called the human side of science. Edward Orton, throughout his career as teacher and investigator, was conspicuous for his attention to the human side of science. His most abstract work was consciously for the benefit of the community, and he ever sought opportunity to make its results directly available. In promoting the interests of the people of his adopted state he incidentally accomplished much for a larger community by helping it to an appreciation of the essential beneficence of the scientific study of nature and man. As an individual he was a diligent and successful laborer in the field which the Association cultivates, and when the Association selected him as its standard bearer it made choice of one who was peculiarly its representative.

The subject to which I shall invite your attention this evening is by no means novel, but might better be called perennial or recurrent; for the problem of our earth's age seems to bear repeated solution without loss of vigor or prestige. It has been a marked favorite, moreover, with presidents and vice-presidents, retiring or otherwise, when called upon to address assemblies whose fields of scientific interest are somewhat diverse—for the reason, I imagine, that while the specialist claims the problem as his peculiar theme of study he feels that other denizens of the planet in question may not lack interest in the early lore of their estate.

The difficulty of the problem inheres in the fact that it not only transcends direct observation but demands the extrapolation or extension of familiar physical laws and processes far beyond the ordinary range of qualifying conditions. From whatever side it is approached the way must be paved by postulates, and the resulting views are so discrepant that impartial onlookers have come to be suspicious of these convenient and inviting stepping stones.

That vain expectation may not be aroused I admit at the outset that I have not solved the problem and shall submit to you no estimates. My immediate interest is in the preliminary question of the available methods of approach, and it leads to the consideration of the ways, or the classes of ways, in which the measurement of time has been accomplished or attempted.

Of the artificial devices employed in practical horology there are two so venerable that their origins are lost in the obscurity of legendary myth. These are the clepsydra and the taper. In the clepsydra advantage is taken of the approximately uniform rate at which water escapes through a small orifice, and time is measured by gaging the loss of water from a discharging vessel or the gain in a receiving vessel. The hour glass is one of its later forms, in which sand takes the place of water. The taper depends for its value as a time piece on the approximate uniformity of combustion when the area of fuel exposed to the air is definitely regulated. It survives chiefly in the prayer stick and safety fuse, but the graduated candle is perhaps still used to regulate monastic vigils.

The pendulum, a comparatively modern invention, excelling the clepsydra and taper in precision, has altogether supplanted them as the servant of civilization. Its accuracy results from the remarkable property that the period in which it completes an oscillation is almost exactly the same, whatever the arc through which it swings. It regulates the movements not only of our clocks, watches and chronometers, but of barographs, thermographs and a great variety of other machines for recording events and changes in their proper order and relation in respect to time.

I must mention also a special apparatus invented by astronomers and called a chronograph. It consists ordinarily of a revolving drum about which a paper is wrapped and against which rests a pen. As the drum turns the pen draws a line on the paper. Through an electric circuit the pen is brought under the influence of a pendulum in such a way that at the middle of each swing of the pendulum the pen is deflected, making a mark at right angles to the straight line. The series of marks thus drawn constitutes a time scale. The electric arrangements are so made that the pen will also be disturbed in consequence of some independent event, such as the firing of a gun or the transit of a star; and the mark caused by such disturbance, being automatically platted on the time scale, records the time of the event.

No attempt has been made to characterize these various time pieces with fullness, because they are already well known to most of those present, and, in fact, the chief motive for giving them separate mention is that they may serve as the basis of a classification. In the use of the clepsydra and taper, time is measured in terms of a continuous movement or process; in the use of the pendulum time is measured in terms of a movement which is periodically reversed. The classification embodies the fundamental distinction between continuous motion and rhythmic motion.

Passing now from the artificial to the natural measures of time we find that they are all rhythmic. It is true that the spinning of the earth on its axis is in itself a continuous motion, but it would yield no time measure if the earth were alone in space, and so soon as the motion is considered in relation to some other celestial body it becomes rhythmic. As viewed from, or compared with, a fixed star the period of its rhythm is the sidereal day; compared with the sun it is the solar day, nearly four minutes longer; and compared with the moon it is the lunar day, still longer by 49 minutes. As the sun supplies the energy for most of the physical and all the vital processes of the earth's surface, the rhythm of the solar day is impressed in multitudinous ways on man and his environment, and he makes it his primary or standard unit of time. He has arbitrarily divided it into hours, minutes and seconds, and in terms of these units he says that the length of the sidereal day is a little more than 23 hours, 56 minutes and 4 seconds, and the average length of the lunar day is a little less than 24 hours and 49 minutes. The lunar day finds expression in the tides and is of moment to maritime folk, but the sidereal is known only to astronomers.

Next in the series of our natural time units is the month, or the rhythmic period of the moon regarded as a luminary. By our savage ancestors, who credited the moon with powers of great importance to themselves, much use was made of this unit, but as progress in knowledge has shown that the influence of the satellite had been vastly overrated, less and less attention has been paid to the returning crescent, and it is only in ecclesiastic calendars that the chronology of civilization now recognizes the natural month. Its shadow survives, without the substance, in the calendar month; and the week possibly represents an early attempt to subdivide it.

In passing to our third natural unit, the year, we again encounter solar influence, and find the rhythm of the earth's orbit echoed and reechoed in innumerable physical and vital vibrations. As the attitude of the earth's axis inclines one hemisphere toward the sun for part of the year and the other hemisphere for the remainder, the whole complex drama of climate is annually enacted, and the sequence of man's activities is made to assume an annual rhythm. The year is second only to the day as a ter-

restrial unit of duration; and as the day is man's standard for the minute division of time, so the year is his standard for larger divisions, and the decade, the century and the millenium are its multiples.

But the rhythms of day and night, of summer and winter, are not the only tides in the affairs of men. At birth we are small, weak and dependent, we grow larger and stronger, we become mature and independent, and then by reproducing our kind we complete the cycle, which begins again with our children. The cycle of human life is the *generation*, a time unit of somewhat indefinite length and varying in phase from family to family, but holding a place, nevertheless, in human chronology.

Still less definite is the rhythm of hereditary rulership, progressing from vigor through luxury to degeneracy, and closing its cycle in usurpation; yet it makes an epoch in the life of a nation or empire, and so the *dynasty* is one of the units of the historian.

The generation and the dynasty are of waning importance in human chronology, and they can claim no connection with the problem of geologic time; but here again I have turned aside for a moment in order to illustrate a principle of classification. The daily rhythm of waking and sleeping, of activity and rest, does not originate with man but is imposed on him by the rhythm of light and darkness, and that in turn springs from the turning of the earth in relation to the shining sun. The yearly rhythm of sowing and harvesting, of the fan and the furnace, does not originate with man but is imposed on him by the rhythm of the seasons, and that in turn springs from certain motions of the earth in relation to the glowing sun. But the rhythm of the generation and the rhythm of the dynasty have origin in the nature of man himself. The rhythms of human chronology may thus be grouped according to source in two classes, the *imposed* and the *original;* and the same distinction holds for other rhythms. The lunar day is an original rhythm of the earth as seen from the moon; the ground swell is an original rhythm of the ocean; but the tide is an imposed rhythm of the ocean, being derived from the lunar day. The swing of the pendulum is an original rhythm, but the regular excursion of the chronograph pen, being caused by the swing of the pendulum, is an imposed rhythm.

In giving brief consideration to each of the more important ways by which the problem of the earth's age has been approached, I shall mention first those which follow the action of some continuous process, and afterward those which depend on the recognition of rhythms.

The earliest computations of geologic time, as well as the majority of all such computations, have followed the line of the most familiar and fundamental of geologic processes. All through the ages the rains, the rivers and the waves have been eating away the land, and the product of their gnawing has been received by the sea and spread out in layers of sediment. These layers have been hardened into rocky strata, and from time to time portions have been upraised and made part of the land. The record they contain makes the chief part of geologic history, and the groups into which they are divided correspond to the ages and periods of that history. In order to make use of these old sediments as measures of time it is necessary to know either their thickness or their volume, and also the rate at which they were laid down. As the actual process of sedimentation is concealed from view, advantage is taken of the fact that the whole quantity deposited in a year is exactly equalled by the whole quantity washed from the land in the same time, and measurements and estimates are made of the amounts brought to the sea by

rivers and torn from the cliffs of the shore by waves. After an estimate has been obtained of the total annual sedimentation at the present time, it is necessary to assume either that the average rate in past ages has been the same or that it has differed in some definite way.

At this point the course of procedure divides. The computer may consider the aggregate amount of the sedimentary rocks, irrespective of their subdivisions, or he may consider the thicknesses of the various groups as exhibited in different localities. If he views the rocks collectively, as a total to be divided by the annual increment, his estimate of the total is founded primarily on direct measurements made at many places on the continents, but to the result of such measurements he must add a postulated amount for the rocks concealed by the ocean, and another postulated amount for the material which has been eroded from the land and deposited in the sea more than once.

If, on the other hand, he views each group of rocks by itself, and takes account of its thickness at some locality where it is well displayed, he must acquire in some way definite conceptions of the rates at which its component layers of sand, clay and limy mud were accumulated, or else he must postulate that its average rate of accretion bore some definite ratio to the present average rate of sedimentation for the whole ocean. This course is, on the whole, more difficult than the other, but it has yielded certain preliminary factors in which considerable confidence is felt. Whatever may have been the absolute rate of rock building in each locality, it is believed that a group of strata which exhibits great thickness in many places must represent more time than a group of similar strata which is everywhere thin, and that clays and marls, settling in quiet waters are likely to represent, foot for foot, greater amounts of time than the coarser sediments gathered by strong currents; and studying the formations with regard to both thickness and texture, geologists have made out what are called *time ratios*,—series of numbers expressing the relative lengths of the different ages, periods and epochs. Such estimates of ratios, when made by different persons, are found to vary much less than do the estimates of absolute time, and they will serve an excellent purpose whenever a satisfactory determination shall have been made of the duration of any one period.

Reade has varied the sedimentary method by restricting attention to the limestones, which have the peculiarity that their material is carried from the land in solution; and it is a point in favor of this procedure that the dissolved burdens of rivers are more easily measured than their burdens of clay and sand.

An independent system of time ratios has been founded on the principle of the evolution of life. Not all formations are equally supplied with fossils, but some of them contain voluminous records of contemporary life; and when account is taken of the amount of change from each full record to the next, the steps of the series are found to be of unequal magnitude. Though there is no method of precisely measuring the steps, even in a comparative way, it has yet been found possible to make approximate estimates, and these in the main lend support to the time ratios founded on sedimentation. They bring aid also at a point where the sedimentary data are weak, for the earliest formations are hard to classify and measure. It is true that these same formations are almost barren of fossils, but biologic inference does not therefore stop. The oldest known fauna, the Eocambrian, does not represent the beginnings of life, but a well advanced stage, characterized by development along many divergent lines; and by comparing Eocambrian life with existing life the paleontolo-

gist is able to make an estimate of the relative progress in evolution before and after the Eocambrian epoch. The only absolute blank left by the time ratios pertains to an azoic age which may have intervened between the development of a habitable earth crust and the actual beginning of life.

Erosion and deposition have been used also, in a variety of ways, to compute the length of very recent geologic epochs. Thus, from the accumulation of sand in beaches Andrews estimated the age of Lake Michigan, and Upham the age of the glacial lake Agassiz; and from the erosion of the Niagara gorge the age of the river flowing through it has been estimated. But while these discussions have yielded conceptions of the nature of geologic time, and have served to illustrate the extreme complexity of the conditions which affect its measurement, they have accomplished little toward the determination of the length of a geologic period; for they have pertained only to a small fraction of what geologists call a period, and that fraction was of a somewhat abnormal character.

Wholly independent avenues of approach are opened by the study of processes pertaining to the earth as a planet, and with these the name of Kelvin is prominently associated.

As the rotation of the earth causes the tides, and as the tides expend energy, the tides must act as a brake, checking the speed of rotation. Therefore the earth has in the past spun faster than now, and its rate of spinning at any remote point of time may be computed. Assuming that the whole globe is solid and rigid, and that the geologic record could not begin until that condition had been attained, there could not have been great checking of rotation since consolidation. For if there had been, it would have resulted in the gathering of the oceans about the poles and the baring of the land near the equator, a condition very different from what actually obtains. This line of reasoning yields an obscure outer limit to the age of the earth.

On the assumption that the globe lacks something of perfect rigidity, G. H. Darwin has traced back the history of the earth and the moon to an epoch when the two bodies were united, their separation having been followed by the gradual enlargement of the moon's orbit and the gradual retardation of the earth's rotation; and this line of inquiry has also yielded an obscure outer limit to the antiquity of the earth as a habitable globe.

One of the most elaborate of all the computations starts with the assumption that at an initial epoch, when the outer part of the earth was consolidated from a liquid condition, the whole body of the planet had approximately the same temperature; and that as the surface afterward cooled by outward radiation there was a flow of heat to the surface by conduction from below. The rate of this flow has diminished from that epoch to the present time according to a definite law, and the present rate, being known from observation, affords a measure of the age of the crust. The strength of this computation lies in its definiteness and the simplicity of its data; its weakness in the fact that it postulates a knowledge of certain properties of rock—namely, its fusibility, conductivity and viscosity—when subjected to pressures and temperatures far greater than have ever been investigated experimentally.

A parallel line of discussion pertains to the sun. Great as is the quantity of heat which that incandescent globe yields to the earth, it is but a minute fraction of the whole amount with which it continually parts, for its radiation is equal in all directions, and the earth is but a speck in the solar sky. On the assumption that this immense loss of heat is accompanied by a corresponding loss of volume, the sun is

shrinking at a definite rate, and a computation based on this rate has told how many millions of years ago the sun's diameter should have been equal to the present diameter of the earth's orbit. Manifestly the earth can not have been ready for habitation before the passage of that epoch, and so the computation yields a superior limit to the extent of geologic time.

Before passing to the next division of the subject—the computations based on rhythms—a few words may be given to the results which have been obtained from the study of continuous processes. Realizing that your patience may have been strained by the kaleidoscopic character of the rapid review which has seemed unavoidable, I shall spare you the recitation of numerical details and merely state in general terms that the geologists, or those who have reasoned from the rocks and fossils, have deduced values for the earth's age very much larger than have been obtained by the physicists, or those who have reasoned from earth cooling, sun cooling and tidal friction. In order to express their results in millions of years the geologists must employ from 3 to 5 digits, while the physicists need but 1 or 2. When these enormous discrepancies were first realized it was seen that serious errors must exist in some of the observational data or else in some of the theories employed; and geologists undertook with zeal the revision of their computations, making as earnest an effort for reconciliation as has been made a generation earlier to adjust the elements of the Hebrew cosmogony to the facts of geology. But after rediscussing the measurements and readjusting the assumptions so as to reduce the time estimates in every reasonable way—and perhaps in some that were not so reasonable—they were still unable to compress the chapters of geologic history between the narrow covers of physical limitation; and there the matter rests for the present.

The rocks which were formed as sediments show many traces of rhythm. Some are composed of layers, thin as paper, which alternate in color, so that when broken across they exhibit delicate banding. In the time of their making there was a periodic change in the character of the mud that settled from the water. Others are banded on a larger scale; and there are also bandings of texture where the color is uniform. Many formations are divided into separate strata, as though the process of accretion had been periodically interrupted. Series of hard strata are often separated by films or thin layers of softer material. Strata of two kinds are sometimes seen to alternate through many repetitions. Borings in the delta of the Mississippi show soils and remains of trees at many levels, alternating with river silts. The rock series in which coal occurs are monotonous repetitions of shale and sandstone. Belgian geologists have been so impressed by the recurrence of short sequences of strata that they have based an elaborate system of rock notation upon it.

Passing to still greater units, the large aggregates of strata sometimes called systems show in many cases a regular sequence, which Newberry called a 'circle of deposition.' When complete, it comprises a sandstone or conglomerate, at base, then shale, limestone, shale and sandstone. This sequence is explained as the result of the gradual encroachment, or transgression, as it is called, of the sea over the land and its subsequent recession.

In certain bogs of Scandinavia deep accumulations of peat are traversed horizontally by layers including tree stumps in such way as to indicate that the ground has been alternately covered by forest and boggy moss. The broad glaciers of the Ice age grew alternately smaller and larger—or else were repeatedly dissipated and reformed—and their final waning was char-

acterized by a series of halts or partial readvances, recorded in concentric belts of ice-brought drift. Of these belts, called moraines of recession, Taylor enumerates seventeen in a single system.

In explanation of these and other repetitive series incorporated in the structure of the earth's crust, a variety of rhythmic causes have been adduced; and mention will be made of the more important, beginning with those which have the character of original rhythms.

A river flowing through its delta clogs its channel with sediment and from time to time shifts its course to a new line, reaching the sea by a new mouth. Such changes interrupt and vary sedimentation in neighboring parts of the sea. Storms of rain make floods, and each flood may cause a separate stratum of sediment. Storms of wind give destructive force to the waves that beat the shore, and each storm may cause the deposit of an individual layer of sediment. Varying winds may drive currents this way and that, causing alternations in sedimentation.

To explain the forest beds buried in the Mississippi silts it has been suggested that the soft deposits of the delta from time to time settled and spread out under their own weight. Various alternations of strata, and epecially those of the coal measures, have been ascribed to successive local subsidences of the earth's crust, caused by the addition of loads of deposit. It has been suggested also that land undergoing erosion may rise up from time to time because relieved of load, and the character of sediment might be changed by such rising. Subterranean forces, of whatever origin, seemingly slumber while strains are accumulating, and then become suddenly manifest in dislocations and eruptions, and such catastrophes affect sedimentation.

A more general rhythm has been ascribed to the tidal retardation of rotation and the resulting change of the earth's form. If the body of the earth has a rather high rigidity, we should expect that it would for a time resist the tendency to become more nearly spherical, while the water of the ocean would accommodate itself to the changing conditions of equilibrium by seeking the higher latitudes. Eventually, however, the solid earth would yield to the strain and its figure become adjusted to the slower rotation, and then the mobile water would return. Thus would be caused periodic transgressions by the sea, occurring alternately in high and low latitudes.

Another general rhythm has been recently suggested by Chamberlin in connection with the hypothesis that secular variations of climate are chiefly due to variations of the quantity of carbon dioxide in the atmosphere.* The system of interdependent factors he works out is too complex for presentation at this time, and I must content myself with saying that his explanation of the moraines of recession involves the interaction of a peculiar atmospheric condition with a condition of glaciation, each condition tending to aggravate the other, until the cumulative results brought about a reaction and the climatic pendulum swung in the opposite direction. With each successive oscillation the momentum was less, and an equilibrium was finally reached.

Few of these original rhythms have been used in computations of geologic time, and it is not believed that they have any positive value for that purpose. Nevertheless, account must be taken of them, because they compete with imposed rhythms for the explanation of many phenomena, and the imposed rhythms, wherever established, yield estimates of time.

The tidal period, or the half of the lunar

* An attempt to frame a working hypothesis of the cause of glacial periods on an atmospheric basis. *Journ. Geol.*, Vol. VII., 1899.

day, is the shortest imposed rhythm appealed to in the explanation of the features of sedimentation. It is quite conceivable that the bottom of a quiet bay may receive at each tide a thin deposit of mud which could be distinguished in the resulting rock as a papery layer or lamina. If one could in some way identify a rock thus formed, he might learn how many half-days its making required by counting its laminæ, just as the years of a tree's age are learned by counting its rings of growth.

The next imposed rhythm of geologic importance is the year. There are rivers, like the Nile, having but one notable flood in each year, and so depositing annual layers of sediment on their alluvial plains and on the sea beds near their mouths. Where oceanic currents are annually reversed by monsoons, sedimentation may be regularly varied, or interrupted, once a year. Streams from a glacier cease to run in winter, and this annual interruption may give a definite structure to resulting deposits. It is therefore probable that some of the laminæ or strata of rocks represent years, but the circumstances are rarely such that the investigator can bar out the possibility that part of the markings or separations were caused by original rhythms of unknown period.

The number of rhythms existing in the solar system is very large, but there are only two, in addition to the two just mentioned, which seem competent to write themselves in a legible way in the geologic record. These are the rhythms of precession and eccentricity.

Because the earth's orbit is not quite circular and the sun's position is a little out of the center, or eccentric, the two hemispheres into which the earth is divided by the equator do not receive their heat in the same way. The northern summer, or the period during which the northern hemisphere is inclined toward the sun, occurs when the earth is farthest from the sun, and the northern winter occurs when the earth is nearest to the sun, or in that part of the orbit called perihelion. These relations are exactly reversed for the southern hemisphere. The general effect of this is that the southern summer is hotter than the northern, and the southern winter is colder than the northern. In the southern part of the planet there is more contrast between summer and winter than in the northern. The sun sends to each half the same total quantity of heat in the course of a year, but the difference in distribution makes the climates different. The physics of the atmosphere is so intricate a subject that meteorologists are not fully agreed as to the theoretic consequences of these differences of solar heating, but it is generally believed that they are important, involving differences in the force of the winds, in the velocity and course of ocean currents, in vegetation, and in the extent of glaciers.

Now, the point of interest in the present connection is that the astronomic relations which occasion these peculiarities are not constant, but undergo a slow periodic change. The relation of the seasons to the orbit is gradually shifting, so that each season in turn coincides with the perihelion; and the climatic peculiarities of the two hemispheres, so far as they depend on planetary motions, are periodically reversed. The time in which the cycle of change is completed, or the period of the rhythm, is not always the same, but averages 21,000 years. It is commonly called the precessional period.*

Assuming that the climates of many parts of the earth are subject to a secular cycle, with contrasted phases every 10,500

*Strictly speaking, 21,000 years is the period of the precession of the equinoxes as referred to perihelion; but the perihelion is itself in motion. As referred to a fixed star the precession of the equinoxes has an average period of about 25,700 years.

years, we should expect to find records of the cycle in the sediments. A moist climate would tend to leach the calcareous matter from the rock, leaving an earthy soil behind, and in a succeeding drier climate the soil would be carried away; and thus the adjacent ocean would receive first calcareous and then earthy sediments. The increase of glaciers in one hemisphere would not only modify adjacent sediments directly, but, by adding matter on that side would make a small difference in the position of the earth's center of gravity. The ocean would move somewhat toward the weighted hemisphere, encroaching on some coasts and drawing down on others; and even a small change of that sort would modify the conditions of erosion and deposition to an appreciable extent in many localities.

Blytt ascribed to this astronomic cause the alternations of bog and forest in Scandinavia, as well as other sedimentary rhythms observed in Europe; and it has seemed to me competent to account for certain alternations of strata in the Cretaceous formations of Colorado. Croll used it to explain interglacial epochs, and Taylor has recently applied it to the moraines of recession.

The remaining astronomic rhythm of geologic import is the variation of eccentricity. At the present time our greatest distance from the sun exceeds our least distance by its thirtieth part, but the difference is not usually so small as this. It may increase to the seventh part of the whole distance, and it may fall to zero. Between these limits it fluctuates in a somewhat irregular way, in which the property of periodicity is not conspicuous. The effect of its fluctuation is inseparable from the precessional effect, and is related to it as a modifying condition. When the eccentricity is large the precessional rhythm is emphasized; when it is small the precessional effect is weak.

The variation of eccentricity is connected with the most celebrated of all attempts to determine a limited portion of geologic time. In the elaboration of the theory of the Ice age which bears his name, Croll correlated two important epochs of glaciation with epochs of high eccentricity computed to have occurred about 100,000 and 210,000 years ago. As the analysis of the glacial history progresses, these correlations will eventually be established or disproved, and should they be established it is possible that similar correlations may be made between events far more remote.

The studies of these several rhythms, while they have led to the computation of various epochs and stages of geologic time, have not yet furnished an estimate either of the entire age of the earth or of any large part of it. Nevertheless, I believe that they may profitably be followed with that end in view.

The system of rock layers, great and small, constituting the record of sedimentation, may be compared to the scroll of a chronograph. The geologic scroll bears many separate lines, one for each district where rocks are well displayed, but these are not independent for they are labelled by fossils and by means of these labels can be arranged in proper relation. In each time line are little jogs—changes in kind of rock or breaks in continuity—and these jogs record contemporary events. A new mountain was uplifted, perhaps, on the neighboring continent, or an old uplift received a new impulse. Through what Davis calls stream piracy a river gained or lost the drainage of a tract of country. Escaping lava threw a dam across the course of a stream, or some Krakatoa strewed ashes over the land and gave the rivers a new material to work on. The jogs may be faint or strong, many or few, and for long distances the lines may run smooth and straight; but so long as the

jogs are irregular they give no clue to time. Here and there, however, the even line will betray a regularly recurring indentation or undulation, reflecting a rhythm and possibly significant of a remote pendulum whose rate of vibration is known. If it can be traced to such a pendulum there will result a determination of the rate at which the chronograph scroll moved when that part of the record was made; and a moderate number of such determinations, if well distributed, will convert the whole scroll into a definite time scale.

In other words, if a sufficient number of the rhythms embodied in strata can be identified with particular imposed rhythms, the rates of sedimentation under different circumstances and at different times will become known, and eventually so many parts of geologic time will have become subject to direct calculation that the intervals can be rationally bridged over by the aid of time ratios.

For this purpose there is only one of the imposed rhythms of practical value, namely, the processional; but that one is, in my judgment, of high value. The tidal rhythm can not be expected to characterize any thick formation. The annual is liable to confusion with a variety of original rhythms, especially those connected with storms. The rhythm of eccentricity, being theoretically expressed only as an accentuation of the precessional, can not ordinarily be distinguished from it. But none of these qualifications apply to the precessional. It is not liable to confusion with the tidal and annual because its period is so much longer, being more than 2000 times that of the annual. It has an eminently practical and convenient magnitude, in that its physical manifestation is well above the microscopic plane, and yet not so large as to prevent the frequent bringing of several examples into a single view. It is also practically regular in period, rarely deviating from the average length by more than the tenth part.

From the greater number of original rhythms it is distinguished, just as from the annual and tidal, by magnitude. The practical geologist would never confuse the deposit occasioned by a single storm, for example, with the sediments accumulated during an astronomic cycle of 20,000 years. But there are other original rhythms, known or surmised, which might have magnitudes of the same general order, and to discriminate the precessional from these it is necessary to employ other characters. Such characters are found in its regularity or evenness of period, and in its practical perpetuity. The diversion of the mouth of a great river such as the Hoang Ho or the Mississippi, might recur only after long intervals; but from what we know of the behavior of smaller streams we may be sure that such events would be very irregular in time as well as in other ways. The intervals between volcanic eruptions at a particular vent or in a particular district may at times amount to thousands of years, but their irregularity is a characteristic feature. The same is true of the recurrent uplifts by which mountains grow, so far as we may judge them by the related phenomena of earthquakes; and the same category would seem to hold also the theoretically recurrent collapse of the globe under the strains arising from the slowing of rotation. The carbon-dioxide rhythm, know as yet only in the field of hypothesis, is hypothetically a running-down oscillation, like the lessening sway of the cradle when the push is no longer given.

But the precessional motion pulses steadily on through the ages, like the swing of a frictionless pendulum. Its throb may or may not be caught by the geologic process which obtains in a particular province and in a particular era, but whenever the conditions are favorable and the connection is

made, the record should reflect the persistence and the regularity of the inciting rhythm.

The search of the rocks for records of the ticks of the precessional clock is an out-of-door work. Pursued as a closet study it could have no satisfactory outcome, because the printed descriptions of rock sequences are not sufficiently complete for the purpose; and the closet study of geology is peculiarly exposed to the perils of hobby-riding. A student of the time problem cannot be sure of a persistent, equable sedimentary rhythm without direct observation of the characters of the repeated layers. He needs to avail himself of every opportunity to study the series in its horizontal extent, and he should view the local problem of original *versus* imposed rhythm with the aid of all the light which the field evidence can cast on the conditions of sedimentation.

Neither do I think of rhythm seeking as a pursuit to absorb the whole time and energy of an individual and be followed steadily to a conclusion; but hope rather that it may receive the incidental and occasional attention of many of my colleagues of the hammer, as other errands lead them among cliffs of bedded rocks. If my suggestion should succeed in adding a working hypothesis or point of view to the equipment of field geologists, I should feel that the search had been begun in the most promising and advantageous manner. For not only would the subject of rhythms and their interpretations be advanced by reactions from multifarious individual experiences, but the stimulus of another hypothesis would lead to the discovery of unexpected meanings in stratigraphic detail.

It is one of the fortunate qualities of scientific research that its incidental and unanticipated results are not infrequently of equal or even greater value than those directly sought. Indeed, if it were not so there would be no utilitarian harvest from the cultivation of the field of pure science.

In advocating the adoption of a new point of view from which to peer into the mysterious past, I would not be understood to advise the abandonment of old standpoints, but rather to emulate the surveyor, who makes measurement to inaccessible points by means of bearings from different sides. Every independent bearing on the earth's beginning is a check on other bearings, and it is through the study of discrepancies that we are to discover the refractions by which our lines of sight are warped and twisted. The three principal lines we have now projected into the abyss of time miss one another altogether, so that there is no point of intersection. If any of them is straight, both the others are hopelessly crooked. If we would succeed we should not only take new bearings from each discovered point of vantage, but strive in every way to discover the sources of error in the bearings we have already attempted.

G. K. Gilbert.

---

*THE EIGHTH GROUP OF THE PERIODIC SYSTEM AND SOME OF ITS PROBLEMS.**

I.

In the early work of Newlands and of Mendeléeff, which subsequently developed into the periodic law, a serious difficulty was met with in dealing with iron, cobalt, nickel, and the metals of the platinum group. In Newlands' modified statement of his law of octaves he says: "The numbers of analogous elements, *when not consecutive*, differ by seven or by some multiple of seven." Thus we find him grouping † cobalt and nickel under a single number; so rhodium and ruthenium; so also platinum and iridium. Cobalt, nickel, palladium, plati-

*Address by the Vice-President and Chairman of Section C., American Association for the Advancement of Science, June, 1900.

† *Chem. News*, 13, 130 (1866).

num and iridium are considered by him analogous elements, each occupying the first place in the octave to which it belongs; iron, rhodium, ruthenium and gold are analogous elements, each occupying the seventh place in its octave; while osmium is included with copper and silver as the second members of their octaves. There was here an easily recognized inconsistency which was not cleared up till many years later Seubert was led by the study of the periodic law to revise the atomic weights of these metals.

In his first summing up of the principles of the periodic law in 1869, Mendeléeff concludes that "elements which are similar as regards their chemical properties have atomic weights which are either of nearly the same value (*e. g.*, platinum, iridium, osmium) or which increase regularly (*e. g.*, potassium, rubidium, cesium)"*. So in most schemes for representing the periodic system, each triplet of these elements is considered as a single element, and because even then they do not seem to fall into regular periodic arrangement, they are cast out, Ishmael-like, into an anomalous eighth group. This is doubtless the reason they have been relatively so much neglected by chemists, and possibly it is not incorrect to say that the chemistry of these metals is less known than that of any other group of well characterized elements. Yet there are certainly no nine nearly related elements which present so many interesting chemical problems, whose solution will so much further our knowledge of chemistry in general. It is the purpose of this address to attract the attention of the members of this Section to this group and some of its many problems.

The ordinary division of these nine metals is into three groups, viz, the common metals, iron, cobalt, and nickel, with an atomic weight of from 56 to 59 and a specific gravity of 7.8 to 8.9; the lighter platinum metals, ruthenium, rhodium and palladium, with an atomic weight 101.5 to 106.5 and a specific gravity of about 12; and the heavy platinum metals, osmium, iridium and platinum, of atomic weight 191 to 195 and specific gravity 21.5 to 22.5.

Of these metals, iron alone can be considered abundant and was the only one known until the eighteenth century. The ores of cobalt and nickel have been known for over two centuries, but the probable presence of a new metal in cobalt ore was first pointed out by Brandt* in 1735, and nineteen years later Cronstedt† determined the existence of nickel. Both of these discoveries were several decades after confirmed by Bergman‡.

It is, however, a curious and interesting fact that a coin of Bactria§ of a date more than two centuries before Christ has been found containing twenty per cent. of nickel and hence quite similar in composition to our modern 'nickels.' There seem, however, to be no references in ancient literature which would indicate that attention was ever attracted by nickel or any of its compounds.

Turning to the platinum metals, the first recognized mention of platinum seems to be in the 'Relacion historica' of Don Antonio de Ulloa (vol. 1, lib. vi, cap. 10, p. 606) published first in 1748, the book being an account of the French expedition of 1735 to the western coast of South America to measure an arc of the meridian on the equator. The passage reads: "In the district of Chocó (Columbia) which contains many placer mines, are also found some, the gold of which, occurring mixed with other substances as metals and rocks, or

Jour. Phys. Chem. Soc. Russ., 1 (1869), 60.

* *Akta Reg. Soc. Sci. Upsala* (1735), 33.

† *K. Svenska Vet. Akad. Handl.* (1751), 293.

‡ *Opusc. Diss.* 20 (1775), 24 (1780) 12 and 14, 25 (1779) 31 and 33.

§ *Ann. der Phys.* (Pogg.), 139, 507 (1870).

being enveloped in them, requires the use of quicksilver for its extraction; and sometimes ores are found which are not worked because of the *Platina* in them (a mineral of such resistance that it is not easy to break it, nor to crush it upon an anvil), for this substance is not affected by calcination, nor is there any means of extracting the metal which it contains, except at the cost of much labor and expense.

From the mention here made, platinum is evidently a well-known substance, and it is by no means improbable that earlier definite mention of platinum may yet be found. In this connection it is interesting to note that there have been many efforts to show that platinum was known at much earlier periods. Scherer* considers from a passage in Balbin's History of Bohemia (P. I., ch. xiv., p. 4) that platinum was known to the Bohemian Jesuits toward the end of the seventeenth century, occurring in the Riesengebirge, for he speaks of a kind of gold so white that one would swear it was silver,† were it not for its weight, ductility, infusibility and insolubility in nitric acid. Julius Scaliger's 'Exercitationes Exotericae de Subtilitate,' published at Frankfort in 1601, makes mention of an infusible metal found in the mines of Mexico and Darien, which might seem to indicate platinum.‡ There have been, moreover, a number of efforts to show that platinum was known to antiquity, under the names of *electrum* or of *plumbum candidum*. Cortinovis§ considers that the electrum of the ancients was platinum, and proves it to his own satisfaction from the Bible, from classic historians of nature and art, from poetry and from Homer.* A similar view is held by Schweigger,† where Pausanius (5, chap. 12, p. 406. Ed. Casaub.) is quoted as mentioning electrum, from which Augustus had made columns, as occurring in nature in the sands of the river Eridanus, and as being very rare, hence much more valuable than the other kind of electrum which is merely an alloy of silver and gold. In 1850 Paravey makes‡ a strong effort to show that Pliny when speaking in his Natural History of *plumbum candidum*, refers to platinum. Pliny speaks indeed of a lead, heavier and more ductile than gold and in Book 34, Chapter 16, gives a definite description of it. To use the quaint translation of Philemon Holland, Doctor of Physicke, published first in 1601:

"Now insueth the discourse of lead, and the nature of it; of which there be two principall kindes, the blacke, and the white. The richest of all, and that which carrieth the greatest price, is that which we in Latine name Plumbum candidum, *i. e.* the white bright lead and the Greeks Cassiteron. But I hold it a meere fable and vaine tale, that all of it is fetched as farre as from the Islands of the Atlanticke Sea, and that the inhabitants of those parts doe conveigh it in little twiggen boats, couered all ouer with feathers. For the truth is that there is found of it in these daies within Portugall and Gallaecia, growing ebbe upon the opmost face of the earth, being among the sands, of a black colour, and by the weight only is knowne from the rest of the soile: and here and there among, a

* *Allg. J. Chem.* (Scherer), 6, 633 (1801).

† Aurum album, quod argentum esse jurares, nisi auro familiares proprietates aliud suaderent, pondus scilicet, extensibilitas, vis eludendi ignem et aquam fortem, solubilitas in aqua regia, etc.

‡ Praeteria scito infunduribus, qui tractus est inter Mexicum et Darien, fodinas esse auricalchi, quod nullo igni, nullis hispanicis artibus, hac tenus liquescere potuit.

§ Opuscoli Scelti Sulla Scienze, etc. Milano, 1760.

* As an instance of the views of Cortinovis may be cited the lines:

Atria cinxit ebur, trabibus solidatur ahenis
Culmen et in celsas surgunt *electra* columnas,

from Claudian's 'Rape of Proserpina' (Book I., v. 164) where it is considered that *electrum* must mean platinum.

† *J. prakt. Chem.*, 34, 385 (1845).

‡ *Compt. Rend.*, 31, 179 (1850).

man shall meet with small stones of the same stuffe, most of all within the brookes, that be dry sometimes of the yere. This sandie and grauelly substance, the mine masters and mettall finers use to wash, and that which settleth downeward, they burne and melt in the furnace. There is found likewise in the gold mines a kind of led ore which they cal Elutia; for that the water that they let into these mines (as I said before) washeth and carrieth down withall certain little blacke stones streaked and marked a little with a kind of white, and as heavy they be in hand as the very ore of gold; and therefore gathered they be with the same ore, and laid in the paniers together therewith; and afterward in the furnace when the fire hath made a separation between them and gold, so soone as they are melted do resolue into the substance of the white lead or tin glance aforesaid."

If Pliny's observation that this variety of *plumbum candidum* is as heavy as gold could be relied upon, the view would be plausible that he was cognizant of platinum, but unfortunately in other places he gives evidence of great inaccuracy in this respect. So too there seems no good reason for considering the metallic *electrum* to be anything other than the natural or artificial white alloy of gold and silver. If there were any question as to whether platinum were known to the ancients, it would seem to be completely answered in the negative by the fact that no platinum object, no nugget, or grain of platinum has been found among ancient remains.

Soon after the introduction of platinum into Europe, no inconsiderable amount of work was done upon it, by Watson, Scheffer, Lewis, Macquer, Marggraf, Bergman, Guyton de Morveau, and others. A few chemists, led by Buffon,* cast doubts upon its elementary character. Buffon when reading his history of minerals to the Dijon Academy held that platinum was an alloy of gold and iron, because it was attracted by a magnet, and, said he, if platinum be a metal there must be a second substance in nature attracted by a magnet. Von Milly believed that mercury was also present in the alloy, but Blondeau,* professor of mathematics at Brest, showed the great improbability that platinum was anything other than a simple metal.

The first suggestion of a practical use for platinum seems to have come from Lavoisier's† observation of its value for laboratory utensils. Many efforts were made in the last decade of the eighteenth century to fuse platinum or to get it into workable form. The first recorded success in this direction was that of Janetty,‡ a Parisian artisan who melted platinum by alloying it with arsenic. It was also alloyed with lead or with bismuth and then cupelled. Before 1800 l'abbé Rochon§ wrapped grains of platinum in platinum foil, heated to redness and then hammered into an ingot. Moussin-Poushkin‖ amalgamated platinum sponge with mercury and ignited in a muffle. Another process is described,¶ of wrapping ammonium chloroplatinate in platinum foil, igniting, and hammering. In 1800 Knight** published his process which with some modifications was generally adopted and remained in use till the metal was fused in the flame of an oxyhydrogen blowpipe by Deville and Debray, more than half a century later. Knight's process consisted in heating platinum sponge in a nearly cylindrical but slightly tapering clay mould, and compressing it by

* *Obs. sur. phys.* (Rozier), 3, 322 (1774).

* *Ibid.*, 4, 154 (1774).

† *Annales de chim.*, 5, 137 (1790).

‡ *Chem. Ann.* (Crell), 1790, ii, 53. The name is also spelled Jeanty, Jeannety, and Jannety.

§ *Ann. der Phys.* (Gilbert), 4, 282 (1100).

‖ *Chem. Ann.* (Crell), 1799, ii, 359.

¶ *Phil. Mag.*, 21, 175 (1805).

** *Ibid.*, 6, (1800).

a few hammer blows while in the furnace. This gave a coherent platinum which could be readily worked into an ingot. It was just about the opening of the century that the discovery of platinum in the Ural Mountains occurred,* and the supply being thus very materially augmented, the use of platinum in the laboratory became established. At the same time the study of the metal from a chemical standpoint led to the discovery of several other metals in the platinum ores. No less than five of the distinguished chemists of that day were working on the ore, with the special aim of separating out other metals which they had reason to believe were present. Palladium was first obtained by Wollaston; Collet Descotils was the *first to publish* indications of what we now know to be iridium, and Fourcroy and Vauquelin at the same time had this metal in hand in an impure form. The real discoverer of iridium should be recognized in Smithson Tennant, who not only separated it in purity, but also at almost the same time found in the same residues the element osmium which seems to have been wholly overlooked by the French chemist. This chapter was closed a few months later by Wollaston's discovery of rhodium.

The episode of the discovery of palladium throws a curious light upon the chemistry and chemists of that period. On May 12, 1803, Chenivix read a paper before the Royal Society † stating that two weeks previously (April 29th) he learned by a printed notice that a substance announced as palladium, a new metal, was offered for sale at the establishment of a well-known mineralogist. The printed notice* opens: "Palladium, or new silver, has these properties among others which show it to be a new noble metal" and then follows the enumeration of eight characteristics of the metal, closing with the address where the new metal could be bought. Chenivix goes on to say that the mode adopted to make known a discovery of so much importance without the name of any creditable person, except the vendor, appeared to him unusual and not calculated to inspire confidence. Having examined a small sample, Chenivix returned and purchased the whole supply. He then says: "We shall cease to wonder at what has been related by these chemists (Berthollet on affinity and Hatchett on alloys), when we learn that palladium is not as was shamefully announced a new simple metal, but an alloy of platina; and that the substance which can thus mask the most characteristic properties of that metal, while it loses the greater number of its own is mercury. Chenivix however on May 4th had written † to Vauquelin that palladium really was a new metal and Chenivix sent him a small specimen. A few days later another letter ‡ makes the claim that palladium is a platinum-mercury alloy. The editors of the *Annales* comment upon this that from Vauquelin's experiments Chenivix is probably wrong. It is interesting to read the comments of Chenivix upon the masking of the individual properties of both platinum and mercury in palladium §, a correct moral drawn from

* Osann says (*Ann. der Phys.* (Pogg.) 11, 311 (1827)) that the first mention he can find of platinum in connection with the Ural Mountains is *Ann. de Chim.*, 60, 317 (1806), where Vauquelin speaks of a rumor that platinum has been discovered in Siberia. Osann could not trace the origin of this rumor.

† *Phil. Trans.*, 93, 290 (1803).

* *Ann. Chim.*, 46, 333 (1803).

† *Ann. de Chim.* 46, 333 (1803).

‡ *Ibid.*, p. 336.

§ "The substance which has been treated of in this paper, must convince us how dangerous it is to form a theory before we are provided with a sufficient number of facts, or to substitute the results of a few observations for the general laws of nature. If a theory is sometimes useful, as a standard to which we may refer our knowledge, it is at other times prejudicial, by creating an attachment in our minds to

a false premise. There was something almost prophetic in the observations of Chenivix, for there are in chemistry no elements whose properties exhibit such great variability when not pure, as do those of the platinum group.

The still anonymous discoverer of palladium immediately offered through Nicholson's Journal a reward of twenty pounds sterling to any one who should manufacture even twenty grains of real palladium,* and many chemists entered into the discussion as to the elementary character of the metal. On June 24, 1804, three days after Tennant had made known the discovery of iridium and osmium, Wollaston read a paper before the Royal Society* acknowledging himself to be the discoverer of palladium. Wollaston had been engaged in an effort to obtain malleable platinum, and having precipitated his solution of the ore with iron, he found a part of this precipitate to be soluble in a mixture of hydrochloric acid with saltpeter, potassium chlorpalladate being formed. He at once concluded that palladium must be a simple metal, because there is 'no instance in chemistry of a distinctly crystallized salt containing more than two bases combined with one acid,' another correct conclusion drawn from a false premise. In his solution Wollaston found also indications of rose-colored soluble crystals which he attributed to another new metal, and to this he gave the name rhodium. This is the explanation of his curious method of making known his discovery of palladium: "On this and on other accounts I endeavor to reserve to myself a deliberate examination of these difficulties, which the subsequent discovery of a second new metal, that I have called rhodium, has since enabled me to explain, without being anticipated even by those foreign chemists whose attraction has been particularly directed to this pursuit."† It is possible from this that Wollaston himself had been led to his work in part at least by the earlier observations of the French chemists.‡

preconceived ideas, which have been admitted without inquiring whether from truth or from convenience. We can easily correct our judgment as to facts and the evidence of experiment is equally convincing to all persons. But theories, not admitting of mathematical demonstration, and being but the interpretation of a series of facts, are the creatures of opinion, and are governed by the various impressions made upon every individual. Nature laughs at our speculations; and though from time to time we receive such warnings as should awaken us to a due sense of our limited knowledge, we are presented with an ample compensation, in the extension of our views, and a nearer approach to the immutable truth." *Phil. Trans.* 93, 317 (1803).

* "Dec. 19, 1803. Editor Nicholson's Journal. Sir: As I see it said in one of your Journals that the new metal I have called palladium is not a new noble metal as I have said it is, but an imposition and a compound of platina and quicksilver, I hope you will do me the justice in your next and tell your readers I promise a reward of £20, now in Mrs. Foster's hands, to any one that will make only 20 grains of real palladium, before any three gentlemen chemists you please to name, yourself one if you like. That he may have plenty of his ingredients, let him use 20 times as much quicksilver, 20 times as much platina, and in short of anything else he pleases to use; neither he nor I can make a single grain. Pray be careful in trying what it is he makes, for the mistake must happen by not trying it rightly. My reason for not saying where it was found was that I might make some advantage of it as I have a right to do. * * * I hope a little bit of whatever is made may be left with Mrs. Foster." Nich. J. 7, 75, 159 (1804).

* *Phil. Trans.*, 94, 419 (1804).

† Nicholson's J., 10, 204 (1805).

‡ Since this address was in type, I have received the interesting Presidential Address of Dr. Thorpe to the Chemical Society (London), in which this episode is treated quite exhaustively. What Wollaston's motive was in bringing his discovery to the notice of the scientific world in so extraordinary a manner, Dr. Thorpe says can only be surmised. Is not however, in view of Wollaston's statement, the motive clearly apparent? He had found palladium; he was in pursuit of rhodium; he knew that at least four other distinguished chemists were also on track of new metals in platinum residues, and any hint such as the publication of his work on palladium

It was in 1803 that Collet-Descotils had read a paper before the Institute of France on the cause of the different colors which affect certain salts of platinum. The residue from the solution of platinum ores in aqua regia and which was thought to be graphite, was still slightly soluble in aqua regia and gave a reddish tint to the potassium chlorplatinate made from it. The metal derived from this red salt was found to be only partially soluble in aqua regia and hence beyond question Descotils had in hand on several occasions a fairly pure iridium, containing, however, in addition to platinum perhaps traces of rhodium. He was convinced that he had here a new metal but he did not investigate its properties.*

The same day that Descotils spoke before the Institute, a second paper on the same subject was presented by Fourcroy and Vauquelin. After extracting the platinum from the ore by aqua regia, they fused the residue with potash and then treated it with acid. These chemists noticed that the potash was colored orange-yellow, but ascribed it to the presence of chromium. They thus missed the discovery of ruthenium, which was to be separated several decades later by Claus. They noticed also on one occasion that the black powder which consisted of iridium and allied metals, was apparently volatile, not recognizing osmium, the cause of the phenomenon. In their second memoir they had iridium fairly pure, and they too noticed the rose color of the double salt, but did not investigate the cause, which is the presence of rhodium.

would help them to anticipate him in the matter of rhodium, while if he kept silence, some of them could not fail to discover palladium.

* Of this Descotils writes (*Ann. de Chim.* 48, 165 1803): On peut déjà conclure que la coloration en rouge des sels de platine est due à l'oxigénation d'une substance qui diffère du platine, et qui présente, lorsqu'elle est a l'état metallique, une grande résistance à l'action des acides.

It was reserved for Tennant the following year to describe clearly the separation of iridium and osmium from the platinum residues, and to name the one from the many different colors through which its chlorids pass, and the other from the intolerable odor of its tetroxid OsO_4.

This osmium contained ruthenium but this was overlooked by Tennant, as it had been by Fourcroy and Vauquelin. A few years later Vauquelin* notes that osmium solutions give a beautiful blue color when reduced by zinc, this being a characteristic reaction, not of osmium but of ruthenium. At a still later date Berzelius noticed the orange color of the fusion of ruthenium with potash and saltpeter, but he attributed it to iridium.

It was in 1828 that the next effort was made to add to the number of the platinum metals. Professor Osann, of the University of Dorpat, announced† the discovery of a new metal in the platinum residues. He obtained long reddish prisms, with high luster, which were easily volatile and which Berzelius pronounced to be new. He had only 0.3 gram, and never obtained any more. The metal in these crystals he named *ruthenium*. They may have been an impure mixture of the tetroxids of ruthenium and osmium. In the next volume of the Annalen‡ he transfers the name ruthenium to another new metal with a golden luster, and at the same time he mentions two other metals, *pluran*, named from pl (atina) and ur (al), which is not further described, and *polin* (πολίος, gray), a gray metal of whose independent existence he seems to have some doubt. Polin was impure iridium with perhaps some ruthenium; pluran was quite possibly a mixture containing some ruthenium; the following year§

* *Ann. de Chim.*, 89, 241 (1814).
† *Ann. der phys.* (Pogg.), 13, 287 (1828).
‡ *Ann. der phys.* (Pogg.), 14, 340 (1828).
§ *Ibid.*, 15, 158 (1829).

Osann acknowledged the metal to which the name ruthenium had been given to be a mixture of the oxids of titanium, zirconium, and silicon.

Fifteen years pass and there appears at the University of Kazan, almost on the far eastern frontier of Russia, a chemist, Claus, who is destined to make greater contributions to the chemistry of the platinum metals, not only than those who had preceded him, but than any one of those who have lived in the nearly forty years since his death. Claus was fortunate in having at his disposal an almost unlimited quantity of platinum residues, from the stock which had accumulated at St. Petersburg during the period of the coinage of platinum. In spite of no inconsiderable effort, I have failed to verify the tradition that the great mass of these residues was sunk in the Neva, to prevent their use in debasing the coinage, and I am inclined to think that the greater portion was distributed to chemists, of which Claus received by far the largest share. In his first publication,* Claus announces the discovery of a new metal, which he calls ruthenium, for the purpose of honoring Osann, whose ruthenium had failed to prove itself an element. It may be mentioned that Osann hardly appreciated the compliment, for he attacked Claus with considerable asperity, accusing him of claiming to discover what Osann himself had discovered. To an impartial critic Osann wholly fails to make out his case. For nearly twenty years Claus continued his work, and his greatest service was in definitely settling the position of the six platinum metals among the elements.† He was the first who clearly showed that these six metals belong in a group by themselves. Up to this time many had held that platinum belonged with gold, palladium with silver, and ruthenium with tin.* He then arranges the elements in three pairs and in two series† as we find them in every table to-day. He also speaks of ruthenium and osmium being especially close to iron, an analogy hardly acknowledged even after the periodic tables of different chemists had appeared. He adds that while platinum is not in the group with gold, it is closely related to it.

Since the time of Claus no new metals have been found in platinum ore or belonging to the platinum group, which have been generally acknowledged as elements. Several chemists have, however, found what they have believed to be new elements, but the quantity has generally been so small that its verification has been impossible. In 1852 Genth‡ found two grains of a white metal in platinum from California gold. Its properties were unlike those of any known element.

In 1862 Dr. C. F. Chandler§ described a new metal in native platinum from Rogue River, Oregon; this possessed properties very similar to those described by Genth, and Chandler concludes that his metal is probably identical with that found by Genth.

In 1869 Guyard discovered a metal in Russian platinum which he described ten years later,‖ and called ouralium. It resembles platinum but is softer and has an

* *Bull. Akad. St. Petersb.* 3 (1845), 38.

† *Ibid.* [2] 2 (1860) 160.

* Loc. cit. "Es is nicht zu leugnen, das in Beziehung einiger weniger Eigenschaften sich solche Analogien aufstellen lassen, allein ich habe Grund diesen nur einen geringen Werth beizumessen, und schliesse mich daher entschieden dem ersten Theile der Anschauungsweise der Verfasser an, indem ich, wie ich mich auch bisher ausgesprochen habe, die Platinmetalle alle für Glieder einer untrennbaren, wohlbegründeten Metallgruppe halte."

† + end of the horizontal series. { Principal Series: Os. Ir. Pt. / Secondary Series: Ru. Rh. Pd. } Vert'cl Series. — end of the horizontal series

‡ *Proc. Acad. Sci. Phil.* 6 (1852), 209; *Amer. J. Sci.* [2], 15 (1853), 446.

§ *Am. J. Sci.* [2], 32 (1862), 351.

‖ *Monit. Scient.* [3], 9 (1879), 795.

atomic weight of 187.5. Its chief difference from platinum is that when fused with potassium cyanide, the melt is orange. This work of Guyard's has never been confirmed.

In 1877 Sergius Kern* announced the discovery of a new metal in platinum residues with atomic weight of 154, to which he gave the name of davyum. This has not only not been confirmed but recently Mallet† has gone over the whole ground with great care, and has shown that in all probability Kern's davyum is a mixture of iridium with rhodium and a little iron. Mallet obtained a residue in much the same way as Kern with similar properties and atomic weight, but proved it to be a mixture. This is the more significant since 154 would be the anticipated atomic weight of a metal lying between the lighter and heavier metals of the group.

The great influence of one of the metals of this group upon the properties of another, even if present in but small quantities, has already been alluded to. It has been long known and a very considerable series of experiments on this point is described by Claus.‡ Nevertheless it remains true that a good proportion of the workers on these metals have, for a time, at least, supposed themselves discoverers of new elements. We may say, however, that not yet is there any reliable evidence of any new metal between the two series, that is, with an atomic weight of about 150; nor has there been any trace of *eka-manganese*, with its atomic weight of 100, and which some chemists would expect to find resembling the platinum metals in its properties.

It is by no means impossible that new metals may be discovered in this group, but the fact that in more than half a century, no confirmed discovery of such has taken place, and that had it not been for a misinterpretation of reactions by which ruthenium was overlooked, we might say that it lacked but three years of a century since a new metal has been discovered, is not calculated to give us much encouragement. There does, indeed, seem, according to the periodic table, to be a place for three metals of atomic weight near 150, but it hardly seems probable that such occur in any of the known platinum ores which have been so thoroughly investigated, unless it be in extremely minute quantity. There is, however, always the possibility of the discovery of new platinum ores, differing in character from those now known, which, whether from the Ourals, or Colombia, or from the Pacific coast, are approximately the same in composition.

Jas. Lewis Howe.
Washington and Lee University.

(*To be concluded.*)

* *Chem. News*, 36 (1877), 4, 92, 114, 155, 164; 37 (1878), 65.

† *Am. Chem. J.*, 20 (1898), 776.

‡ C. Claus; Beiträge zur Chemie der Platinmetalle, Dorpat, 1854, chap. iv. Modificationen, welche die ursprünglichen Reactionen der einzelnen platinmetalle durch Beimengungen der übrigen Metalle aus dieser Gruppe erfahren, p. 42.

THE ROYAL SOCIETY OF CANADA.

The nineteenth meeting of the Royal Society of Canada was held in Ottawa, Canada, from May 28th to May 31st inclusive, in the Assembly Hall and rooms of the Provincial Normal School. Besides fellows of the Society from various provinces there were delegates from affiliated societies in all parts of the Dominion of Canada who reported as to the work done by them. Rev. Professor Clark, the able principal of Trinity University, Toronto, delivered the annual address 'On the Work of the Royal Society.' Numerous papers bearing upon history, science and belles-lettres were read.

Dr. L. O. Howard, the eminent economic entomologist from Washington, delivered a most practical and admirably illustrated lecture, on the evening of May 31st, His

Excellency, the Governor-General of Canada, Lord Minto, presiding. A deputation of fellows of the Royal Society waited upon Premier Sir Wilfred Laurier, and members of his cabinet urging upon them the necessity of erecting a national museum building in which to house, safely and well, the immense collections which have been acquired by the Geological and Natural History Survey of Canada since 1842. This deputation consisted of Rev. Professor Clark, Dr. G. M. Dawson, Sir Sandford Fleming, Sir James Grant, President Loudon, Monseigneur Laflamme (rector of Laval University, Quebec), Hon. Joseph Royal, Dr. L. H. Fréchette, Hon. Premier Marchand, Dr. George Stewart, Professor John Cox, of McGill University, and the member of Parliament for Ottawa, Dr. N. A. Belcourt. The deputation was well received and a definite promise made that an item would be placed in the supplementary estimates for the coming year toward the erection of a National Museum.

Amongst the scientific papers which no doubt prove of more interest to the readers of SCIENCE than the historical or purely literary of the French and English Sections, the following are noted:

MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES.

On the Depression of the Freezing-Point by Solutions Containing Sulphuric and Hydrochloric Acids: By JAMES BARNES, M.A., Dalhousie College, Halifax, N. S. Communicated by Professor J. G. MacGregor.

The object of this paper is to find out whether or not the depression of the freezing-point by solutions containing (1) sulphuric acid, and (2) sulphuric and hydrochloric acids, is calculable by the aid of the dissociation theory and of electrically determined ionization coefficients, and if so on what assumption as to the mode of ionization of the sulphuric acid. Kryoscopic observations on these solutions are of interest because sulphuric acid is usually supposed to divide into H and HSO_4 as ions in somewhat strong solutions and into 2H and SO_4 in extremely dilute solutions, the change from the one to the other mode of ionization occurring gradually as dilution is increased. The possibility of predicting the depression, therefore, forms a test not only of the general applicability of the dissociation theory, but also of the electrical method of determining the ionization coefficients and of the current view of the mode of ionization of sulphuric acid. A modification of Loomis's method has been used for the determination of the freezing-points, and Kohlrausch's method for the determination of conductivities.

On the Relative Bulk of Weak Aqueous Solutions of Certain Sulphates and their Constituent Water: By CHARLES M. PASEA, B.Sc., Dalhousie College, Halifax, N. S. Communicated by Professor J. G. MacGregor.

Dilute solutions of several of the sulphates have been found to possess a smaller volume than the water which they contain when in the free state. The object of this paper is to determine whether or not this is so in the case of solutions of the sulphates of sodium, manganese, cadmium and iron. The requisite observations of density were made with an Ostwald-Sprengel Pycnometer, with an accuracy of about 1/200 per cent. which in most cases was found to be sufficient for the purpose in hand.

A Universal Electrical Measuring Apparatus: By W. LASH MILLER, B.A., Ph.D., and F. B. KENRICK, B.A., Ph.D.

Mathematical Notes: By J. H. MCDONALD, B.A., University of Toronto. Communicated by Professor Baker, Ph.D.

The paper is divided into three parts, and deals with the development of theorems on the following subjects: (1) Special bi-

quadratic involutions and the transformation of elliptic integrals. (2) The representation of a number as the sum of two squares. (3) The twisted biquadratic curve of the first species.

Electrical Screening in Vacuum Tubes: By J. C. McLennan, B.A., Demonstrator in Physics, University of Toronto. Communicated by President Loudon.

The paper deals with a changing effect observed by Professor J. J. Thomson in connection with his experiments on Faraday cylinders inserted in vacuum tubes. The effect referred to is traced to electric conduction along the surface of the glass walls of the tube. Insulators such as sealing wax are shown to be quite unreliable in electrometric work without inner tubes, when voltages such as those produced by an induction coil are used. The importance of good earth connections is developed and Faraday cylinders inserted in vacuum tubes are shown to act as perfect electrical screens unless made of metal thin enough to permit cathode rays to pass through.

Canadian Experiments with Nitragin for promoting the Growth of Legumes: By Frank T. Shutt, M.A., F.I.C., F.C.S., and A. T. Charron, B.A.

By means of diagrams and photographs Mr. Shutt indicated the striking results recently obtained at the Central Experimental Farm or Station at Ottawa in soil-inoculation. The paper when published will be copiously illustrated. Fellows of Section IV. attended the meeting in Section III. during the reading of this important paper.

An Apparatus for the Determination of the Melting Point of Fats: By Frank T. Shutt, M.A., F.I.C., F.C.S., and H. W. Charlton, B.A., Sc.

On Soil Temperature: A continuation of papers presented at preceding meetings. By Prof. C. H. McLeod, M.E.

GEOLOGICAL AND BIOLOGICAL SCIENCES.

The Nepheline Rocks of Ice River, B. C: By A. E. Barlow, M.A., D.Sc. Communicated by Dr. G. M. Dawson.

Among the rock specimens collected by Dr. G. M. Dawson, in 1884, are some which seem to possess many points of rather unusual interest at the present time, illustrative for the most part of the phenomenon of magmatic differentiation, with which of late we have become more familiar through the labors of Vogt, Brögger and others. The specimens in question were obtained from exposures along and in the vicinity of Ice River, a branch of the Beaverfoot River in British Columbia, about eight miles southeast of Leanchoil and Ottertail stations on the Canadian Pacific Railway. The hand specimens, which were made the subjects of examination, were of necessity rather hurriedly collected and were chosen mainly as representing the various phases of this igneous complex. It is therefore a very agreeable surprise to find that the material thus selected at a time when magmatic differentiation was but little understood, should illustrate a passage so complete that no appreciable gap occurs unrepresented by specimens from the most basic Ijolite containing 36.988 per cent. of silica to ordinary nepheline and sodalite syenite containing 53.638 per cent. of silica.

Notes on North American Species of Dadoxylon: By Professor D. P. Penhallow, of McGill University.

The author brings under review a large amount of material collected by the late Sir William Dawson, representing various species of the genus *Dadoxylon*, and he also describes new species of allied plants from the Cretaceous and Permian of Kansas from the collections of Professor C. S. Prosser. The plants formerly included under the name of *Dadoxylon*, are now to be regarded as falling into the three principal groups, of

which the first, extending through Paleozoic time, properly belong to the genus *Cordaites*, which is now fairly well known through its fruit, flowers, leaves and stem structure. The second group embraces plants of the same general Araucarian type, but ranging through the more recent formations commencing with the Jurassic. The third group is reserved under the old name of *Dadoxylon*, for all those plants which cannot be readily assigned to a given and well recognized genus, and from which they may be transferred as occasion requires.

The present revision eliminates many of the errors of the earlier descriptions, and draws attention to important characters hitherto overlooked.

Quarry and Workshop of the Stone Age in New Brunswick: By G. F. MATTHEW, A.M., LL.D.

The author describes a locality on the St. John River in New Brunswick, which appears to be the source of certain carnelian weapons and implements that have been found at various points on the River St. John. The locality is at Washadunoak Lake, in Queen's County.

Notes on the Physical Feature and Geology of the Area between the Lower Ottawa and the St. Lawrence Rivers: By R.W. ELLS, LL.D.

This paper discusses some of the points relating to denudation which have been furnished by a series of borings recently made in the area south of the Ottawa River. From these the presence of a preglacial channel of that river of considerable depth is clearly shown following in part the lines of the Canada Atlantic and the Canadian Pacific railways. The thickness of the several formations of the Palæozoic formations in this part of the basin is also considered, and the presence of several important faults and anticlinals which traverse the district is considered, and their probable location given. These features are of interest at the present time in view of the inquiries recently made as to the possible occurrence of natural gas and oil in certain portions of this basin.

The Palæozoic Formations of Eastern Canada: By HENRY M. AMI, M.A., D.Sc., F.G.S., of the Geological Survey of Canada. Communicated by Dr. Fletcher.

Considerable discussion has arisen of late regarding the place which many of the geological formations of Eastern Canada occupy in the column of the Palæozoic period. There is much confusion in the variety and use of many geological, geographical and other terms in describing or defining various formations in this portion of Canada.

An attempt is made to present a simple and at the same time comprehensive classification of the various strata which compose the earth's crust and belong to the Palæozoic period. Many interesting questions in the nomenclature of Canadian rock formations are discussed and such names introduced as will serve to designate many hitherto unrecognized or undifferentiated formations in Canada.

Some Recent Work in Economic Entomology. Presidential Address of Section: By the REV. DR. BETHUNE.

In his presidential address Dr. Bethune presented a most comprehensive and practical treatise giving historical references and data bearing upon researches in economic entomology in Canada. From the days of small beginnings to the present specific legislation, restricting the encroaches and ravages of insect pests, as well as encouraging the application of every scientific fact of value to man in the department of agricultural pursuits, the author points out what has been, and what is, being done.

Sponges from the Coasts of North-Eastern Canada and Greenland: By LAWRENCE M. LAMBE, F.G.S. Communicated by Dr. Whiteaves.

The present communication forms the fifth of a series of papers, four of which have already appeared in the transactions of this Society, three of these are upon the recent marine sponges of the Pacific and one on those of the Atlantic or eastern coast of Canada, mainly from the Gulf of St. Lawrence and the coast of Nova Scotia. The paper now submitted is supplementary to the one last mentioned and treats of the more northern forms. It is based upon a collection received from Professor D'Arcy Thompson of University College, Dundee, Scotland. The Monaxonida, Tetractinellida, and Calcarea are represented by twenty species, half of which are described as new. Six octavo plates of drawings illustrate the descriptions and show the spicules and their position in the skeleton as well as the general form of the sponges.

The Cerebral Neurons in relation to Memory and Electricity: By Sir James Grant, K.C.M.G., M.D.

The brain neurons and cells, like the cells in other tissues of the body, as years pass on, give evidence of lessening power and activity. The line of present investigation demonstrates that the electrical current through the brain rotates its molecules to such a degree as to produce a most noticeable physiological response, in the direction of improved memory.

Un éboulement à St. Thuribe-de-Vincennes, comté de Champlain: Par Mgr. J. C. Laflamme.

Modifications remarquables causées dans le régime de la rivière Ste-Anne par l'éboulement de St-Alban: Par Mgr. J. C. Laflamme.

These two papers by the Rector of Laval University, Quebec, deal with important geological phenomena affecting the Pleistocene or later Quaternary boulder clays, marine clays, sands and gravels of the north shore of the St. Lawrence. There the streams which flow into this river are now cutting into these newer and uncemented rock-materials in order to form a river bed, and what appears to be a period of unstable equilibrium has set in, leading to many disastrous landslides and landslips in which many human lives have been lost, not to speak of destruction of other life and property.

The Honorary Secretary's Annual Report dealt with the progress of research in the various sections throughout Canada. The preservation of the site of Louisbourg, Nova Scotia, the proposed National Museum, the death and loss to science and the Society of its first president, Sir William Dawson, the proper equipment of a Hydrographic Survey for Canada, tidal observations and other historical as well as literary results were referred to in an able and eminently practical manner.

The following is a list of the officers of the society elected for the ensuing year: *President,* Dr. Louis Honoré Fréchette, C.M.G.; *Vice-President,* President Loudon of Toronto University; *Honorary Secretary,* Sir John G. Bourinot; *Honorary Treasurer,* Dr. James Fletcher.

In the Geological and Biological Section the following officers were elected: *Chairman,* Dr. A. H. Mackay, Halifax, Nova Scotia; *Vice-Chairman,* Professor F. D. Adams, McGill University, Montreal; *Secretary,* Professor G. U. Hay, St. John, New Brunswick.

In the Physical and Mathematical Science Section, the following were chosen: *Chairman,* President Loudon; *Vice-Chairman,* Dr. R. F. Ruttan; *Secretary,* E. Deville, Surveyor-general of Canada, Ottawa.

H. M. Ami.

SCIENTIFIC BOOKS.

The Logical Bases of Education. By J. Welton, M.A. London, Macmillan & Co. 1899. Pages xvi + 288.

This book is one of a series, 'Macmillan's Manuals for Teachers,' edited by Oscar Brown-

ing, M.A., Principal of the Cambridge University Day Training College, and S. S. F. Fletcher, B.A., Ph.D., Master of Method in the same institution. Although the book is written especially for teachers, it is not a book on education, save indirectly and incidentally. Only one chapter deals directly with Education, and elsewhere throughout the book, even the word education is rarely used.

But it should be said at once that the book is none the worse for that. There are many books —books on psychology, ethics, hygiene, for example—which do not deal specifically with education, yet no teacher can afford to dispense with a serious study of the subjects of which they treat. Mr. Welton's 'Logical Bases of Education' is such a book. At the same time, the title is somewhat misleading. The reader who expects to find here a logical, *i. e.*, a well-reasoned discussion of the fundamental principles of education—of the scope and meaning of the education of children and youth for individual development and for social service—will be disappointed. So also will the reader who expects to find an exposition of the application of logic to the processes of education, in detail—to teaching and governing.

It is only fair to say that the author had no intention of meeting such expectations. His purpose is stated in the first paragraph of his preface: "The aim of this book is to set forth the rational bases of all true educational work. It is believed that such bases can only be found in those modern developments of logical theory which have marked the latter half of this century." In accordance with this purpose, Mr. Welton's book is an elementary treatise on epistemology and logic. It consists of chapters on the 'General Nature of Knowledge'; 'Postulates of Knowledge'; 'Knowledge and Language'; 'Knowledge and Logic'; 'Nature of Judgment'; 'Types of Judgment'; 'Formal Relations of Propositions'; 'The Method of Knowledge'; 'Deductive Inference, Syllogism, Construction'; 'Outline of Inductive Method'; 'Observation'; 'Testimony'; 'Hypotheses'; 'Direct Development of Hypotheses'; 'Indirect Verification of Hypotheses'; 'Definition, Classification and Explanation'; 'Logic and Education.' And these chapters are followed by fourteen pages of 'Exercises in Inference'. There is also a serviceable index.

The author's discussion of the topics enumerated is clear and interesting. His only claim to originality consists in the form in which the materials are presented. The sources on which he has drawn for inspiration and guidance, and even for much of his subject-matter—for quotations abound—are referred to in footnotes, and these footnotes are very numerous. At the same time it is clear that he has an independent command of his subject; and he has generally chosen his authorities well.

When Mr. Welton comes to discuss specifically, in the last chapter, the bearing of logic on education, we find him, very properly, cautioning the teacher against expecting to derive detailed rules of procedure from logic any more than from psychology. "Both sciences give general guidance only. Psychology investigates the forms of actual mental activity common amongst men and children, and, therefore, a study of psychology aids the educator by suggesting to him the best ways of awakening such activity. Logic, on the other hand, is regulative, and helps the educator to determine the general lines on which such activity should proceed to attain the goal of knowledge. . . . But the subject matter of the thought and the consequent character of the knowledge gained by the pupils can be determined neither by psychology nor by logic. . . . Logic warns us to insist on sufficient evidence; but logic alone cannot decide when the evidence is sufficient."

So much, in brief, for logic. "The function of education," Mr. Welton tells us, "is to lead the child to find his true place and his true work in the universe." Without stopping to comment on the adequacy or inadequacy of this definition of the function of education, or on its full meaning, as stated, particularly on the phrases 'true place' and 'true work,' we may assume that the definition is intended to cover an education broad enough and deep enough to meet the needs of individuals, both as individuals and as members of a democratic society.

To fulfill this function education must enable every one to understand 'the universe,' at least to some extent; and further, "the universe which a child must learn to understand is a

social and a moral universe as well as a physical one; the facts of experience with which he starts are found in his relations to his fellows as well as in those of the material world. In these facts, too, he must find laws, and through laws he must pass to the conception of that moral system, in which alone he can find the true freedom of rational and self-realizing activity."

Having set forth his view of the function of logic and of education, Mr. Welton is prepared to discuss their relation to each other. The points which logic emphasizes in educational theory, he says, are (1) 'that all true education must be relative to the society in which it is given'; and (2) 'that logic equally with psychology, teaches the educator that the attainment of knowledge is the result of mental exertion.'

That these are fundamental principles of a rational educational theory, every one will admit. Both deserve strong emphasis; and at the present stage of the development of educational theory, particularly the first. I say particularly the first, because the second has been emphasized from time immemorial, while the first has only recently come to receive the attention it deserves at the hands of writers and speakers on education. Education is primarily a social study, like economics, or government. The development of the individual is fruitless unless it proceeds with constant reference to his membership in the contemporary social organism; and the maintenance, organization, and direction of education constitute one of the most important functions of society.

Both of these points are discussed briefly by Mr. Welton. One finds himself regretting that so little space is devoted to the discussion of these important topics; and the value of the book consists, not in a fresh contribution to educational theory, nor in a discussion of the relation of logic to educational theory; but in the general intellectual stimulus such a book must give to every earnest teacher.

The teacher may learn from this book what knowledge is, and how knowledge is tested and assimilated. But he will not find in it an enumeration of the kinds of knowledge to be sought, nor a discussion of the relative efficacy of different kinds of knowledge in promoting individual and social well being. He will get from it no teaching devices, but he may expect to derive from it valuable assistance toward gradually developing within himself the right professional attitude throughout the whole range of his activity.

Paul H. Hanus.
Harvard University.

The Theory and Practice of Interpolation, including Mechanical Quadrature and other Important Problems concerned with the Tabular Values of Functions, with the requisite tables. By Herbert S. Rice, M.S., Assistant in the Office of the American Ephermis, and Professor of Astronomy in the Corcoran Scientific School, Washington, D. C. Lynn, Mass., The Nichols Press. 1899.

Perhaps the first impression which this book produces is one of surprise that the author has found enough material relating to interpolation to fill 234 pages of small quarto. A brief inspection, however, shows that we have to do with a work dealing with most if not all of the important problems which arise in connection with the formation and use of the numerical tables which play so conspicuous a part in applied mathematics. In short, we find here a development not only of the familiar processes of interpolation, but those of numerical differentiation and integration, with a variety of applications to astronomical and other problems.

The author's preface informs us that he has attempted no marked originality, either in subject matter or method. "Indeed, sufficient has hitherto been written of interpolation, quadratures, etc., to firmly dissuade one from such an endeavor." * * * "But while viewing the matter in this practical sense, the writer regards his work as no mere compilation."

In the development of the subject the derivation and discussion of the important formulæ of Newton, Stirling and Bessel naturally constitute the basis of the structure. As this work progresses we have each important step illustrated by a number of numerical examples, together with the development of such precepts as are important in the practical application. For instance, in the great majority of cases we have to do with numerical quantities which, like the familiar logarithmic and trigonometrical

tables, can only be regarded as approximations to the truth. In arranging the computation of such a series of values it becomes a very practical matter so to select the intervals as to avoid unnecessary labor on the one hand and the possible introduction of inadmissible errors in the interpolated values on the other. We have here the practical rule evolved showing that this may ordinarily be accomplished by choosing our intervals such that differences beyond the fifth order may be disregarded. Of course, in the very uncommon case of a rational integral function we may reach absolute accuracy by carrying our computation to the point where the differences vanish.

The subject of mechanical quadrature is doubtless more familiar to the mathematical astronomer than to any other class of readers. Owing to the convenience and facility with which it may often be applied to the evaluation of definite integrals it seems to deserve a more prominent place in works treating of applied mathematics than is commonly the case. Here we find the processes of both single and double integration very fully developed, based in turn on Newton, Stirling and Bessel's formulæ.

Every one naturally assigns a somewhat exalted position to his own special line of investigation. It is, therefore, perhaps not surprising to find, on page 79, what to some may appear to be a somewhat 'dark saying,' viz: "Interpolation has undoubtedly done more for mathematical science than any other discovery excepting that of logarithms." Not to mention the Arabic system of notation, why may we not with equal propriety make a like assertion in regard to multiplication?

Among the problems solved the following are suggestive:

To solve any numerical equation whatever involving but one unknown quantity.

Given a series of numerical functions embracing a maximum and minimum value. To find the value of the argument which corresponds to the maximum and minimum function.

An appendix deals with symbolical methods. Fifteen pages are given to tables, principally the coefficients in Newton, Stirling and Bessel's formulæ, while two pages devoted to the bibliography of the subject complete the work.

Naturally a treatise like this will interest only a limited class of readers, such as workers and students in astronomy and mathematical physics. To all these it can be cordially recommended.

C. L. DOOLITTLE.

FLOWER OBSERVATORY.

BOOKS RECEIVED.

Education in the United States. A Series of Monographs prepared for the United States exhibit at the Paris Exposition, 1900. Edited by NICHOLAS MURRAY BUTLER. Albany, N. Y., J. B. Lyon Company. 1900. In two volumes. Pp. xviii+977.

Department of Geology and Natural Resources of Indiana. 1899. W. S. BLATCHLEY. Indianapolis, Wm. B. Burford. 1900. Pp. 1078.

North America. RALPH S. TARR and FRANK M. MCMURRY. New York and London, The Macmillan Co. 1900. Pp. xix+469. 75 cts.

Familiar Fish, their Habits and Capture. EUGENE MCCARTHY, with an introduction by DAVID STARR JORDAN. New York City, D. Appleton & Co. 1900. Pp. xi+216. $1.50.

A Book of Whales. F. E. BEEDARD. New York, G. P. Putnam's Sons; London, John Murray. 1900. Pp. xv + 320.

Physiology for the Laboratory. BERTHA MILLARD BROWN. Boston, U. S. A., Ginn & Company. 1900. Pp. v + 167.

A Brief History of Mathematics. KARL FINK. Translated by W. W. BEMAN and D. E. SMITH. Chicago, Open Court Publishing Co. 1900. Pp. xi + 333. $1.50.

Exploitation technique des forêts. M. H. VANUTBERGH. Paris, Gauther-Villars. 1900. Pp. 176.

La garance et l'indigo. GEORGE F. JAUBERT. Paris, Gauthier-Villars. 1900. Pp. 166.

Lehrbuch der Photochromie. WILHELM ZENKER. New edition edited by B. SCHWALBE. Braunschweig, F. Vieweg und Sohn. 1900. Pp. xiii + 157.

Das soziale und sittliche Leben erklärt durch die seelische Entwicklung. J. MARK BALDWIN. Translated from the second English edition by DR. R. RUEDEMANN, with preface by DR. PAUL BARTH. Leipzig, J. A. Barth, 1900. Pp. xv + 466.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of the Boston Society of Medical Sciences* for May is more exclusively technical than usual. Harold C. Ernst and W. H.

Robey, Jr., present some 'Studies in the Mechanism of Agglutination,' W. R. Brenckerhoff describes 'The Pathology of Azoturia,' and A. W. Balch notes 'A Possible Cause of Azoturia,' Allen Cleghorn discusses 'The Physiological Effects and the Nature of Extracts of Sympathetic Ganglia,' R. W. Lowett has a note on 'Movements of the Normal Spine in their Relation to Scoliosis,' and Harold C. Ernst treats of 'Actinomycosis of the Udder of the Cow.'

DISCUSSION AND CORRESPONDENCE.

THE MISUSE OF TECHNICAL TERMS.

When a layman discourses upon a professional subject, as when a cobbler expounds electricity, he may be excused for lack of familiarity with technicalities, and for a consequent misuse of technical terms, though one may question the propriety of his posing as an authority on the subject. The case is different with a professional man who has acquired the right to speak by reason of high position or meritorious work, or both. A misuse of terms in speaking to others of his own profession would probably not affect them seriously, as they would perceive the error and discern the truth that is behind it, or the mistake, if there be any, in the conclusions. But when he addresses an audience of laymen, it is incumbent upon him to be careful of his language, especially in scientific matters, since these are loaded down with technical terms of great exactness in meaning, the wrong use of which may result to the uninitiated in error as well as confusion. To be sure, the use of abtruse or uncommon terms where common words would convey the true meaning is tiresome pedantry in professor and layman alike, but whether the words are common or uncommon, let them be used correctly.

In these days of specialties and specialists a highly trained authority in one profession is a layman among the members of another, and to some degree is at their mercy as to technical terms; still more so are those who, without special training, but with intelligence enough to appreciate the ability of scholars, and with a corresponding interest in such features of the various professions as touch upon their life and experience, must depend upon what they can get from the utterances of professional men in quasi-scientific or semi-professional form, to satisfy their thirst for knowledge. They constitute the greater portion of the readers of scientific journals which are not strictly technical, and they want expressions in regard to science that are more authoritative than those appearing in the daily newspaper, where, for example, we read from time to time that a man has taken an electric *current* of an incredible number of volts. The diffusing and popularizing of science has introduced its nomenclature to a wide circle of such interested but imperfectly trained readers, and has made accuracy in the use of terms more important now than ever before. There is no need to go to excess in technicalities. Now and then we encounter papers or even extended treatises in which the author delights in coining words, after the manner of a Heine or a Richter, apparently expecting thereby to enrich our vocabulary, but while occasionally a term thus introduced stays, most commonly it falls out of use very speedily. That is something that takes care of itself. Our only contention is that a technical term should be used correctly, if at all, and that this is the more imperative if the term is not a rare one.

It is true that in some branches of science, possibly in all branches, there are theories or hypotheses, not yet well enough established, phenomena not well enough understood to make it possible to give to the terms the exact significance they may come to possess later. This was illustrated in the discussions that abounded four years ago, regarding the X-rays, and the proper words to designate the radiant agent and the pictures produced by it. In response to a request for a suitable name for the latter, no fewer than twenty were suggested to *The Electrical World*, with special reasons for each one. Of these twenty none has been generally adopted, and today the pictures may be called by any one of several names without violating propriety or precision. It is quite different, however, in regard to certain names in subjects that have passed a transition stage, and probably in none has the nomenclature been more fully developed or better established than in mechanics. In this science new words are proposed from time

to time, but not to change or to substitute those already in use. There was a time when the word 'energy' (not the idea) was new; when force was confounded with work; when power was not generally so completely distinguished from both force and work as it now is. There was then justification for Grove to write of 'The Correlation and Conservation of Forces,' and for Helmholtz to discuss the 'Conservation of Force' (*Erhaltung der Kraft*). But from the somewhat turbid and confused use of terms fifty years ago, there crystallized out a clear and well-defined meaning to go with each one of several names, and these have become so well established that there is little excuse for misuse of them. Of these force, work, energy, and power are or should be among the most familiar, and a scientific writer who confounds one of them with another is as gravely at fault as a literary critic who confounds will and shall, or lie and lay.

It was a little surprising, therefore, not very long ago to read in a leading educational journal, an article by the physical director of a leading university, discussing such exercises as jumping, running, and the like, seriously comparing the *force* necessary to raise the performer six feet with that required to lift him one foot, and implying that the force increased with the height. Just when the laws of gravitation were so changed as to make a man heavier at two feet above the earth than at a height of one foot it would be interesting to learn. That the impulse needed to give him the requisite velocity to rise a definite height, might be acquired by means of *any* force in excess of his weight according to the time during which it is exerted was overlooked or at least not taken into account. In other portions of the article, also appeared misconceptions of the relations of force exerted, time of its action, work expended, and energy acquired, as witnessed by such expressions as 'number of foot pounds lifted,' 'every pound of energy,' etc. It would be ungracious to doubt that the author knew what he meant, but he used technical terms in mistaken senses.

Still more awry are the statements of a writer in a recent number of one of the best and most popular engineering magazines, in expatiating upon the power in a pound of coal. On their face these statements are striking, so much so as to be reprinted by newspapers culling the best extracts from the current literary and scientific magazines. Examined critically they are astonishing. The writer is at some pains in the beginning to explain the meaning of work and to point out that 'in all mechanical work we must consider the element of time,' and then follows with statements that ignore it, by contrasting the energy of the pound of coal with a man-power, or a horse-power. He recurs frequently to the idea 'that this pound of coal contains within it the power of 236 horses.' Its power might as well have been declared that of 472 horses, or of only 118 horses, or of any other number. 'It is interesting,' he continues, 'to follow this out in order to find how much of the power which nature has given us in this pound of coal we are able to get out of it.' Nature has given us not 236 horse-power in the pound of coal, but an indefinite power, and if we can get any work out of it the power is only limited by the rate at which the work can be obtained; for example, the number of foot-pounds per minute.

Apparently the reason in some of these instances for using the word power instead of energy is the idea that possibly the latter term may be less familiar to the reader than the former; but if both are to be used in a strictly technical sense, one is probably as generally understood as the other, and certainly if the author had taken as much pains to define energy in the beginning as he did to define power, he would have cleared the way for the use of the term in its proper sense instead of continually using the other word in a sense at variance with his own explanation. It is true that we do sometimes come upon the word power for force, as where the power and power arm, are compared with the resistance or the weight and its arm. The term *activity* has been introduced to get rid of the tendency to misuse the word power, but even if we admit the untechnical meaning of the word as it appears in the title of the article referred to, the moment it appears in the compound 'horse-power' it is inevitably technical in form and in meaning. As such it is not force, nor work, but rate of working.

One is not surprised at such confusion of meanings in the productions of men who appear from time to time with crude and hazy schemes for correcting or overthrowing all existing systems of science or philosophy, and who make professors weary by their importunities, but one does not look for it in an honored seat of learning. To find it there makes one wonder whether Helmholtz is unknown, or Maxwell has lived in vain.

Although mechanics as the oldest of sciences has been chosen for these illustrations it is likely that every other branch of science can show similar perversions. We have even known the 'parallels of longitude' to be referred to in all seriousness, but as that was not uttered by a scientific man it is rather to be smiled at than criticized.

D. W. Hering.

CORRECTION.

In No. 277 of Science, I stated that the $MgCl_2$ solution used in my experiments on artificial parthenogenesis was a 20/8*n* solution. I have since found that the assistant who made the Mg-solution used and who has left the laboratory must have made a mistake as the solution contained only about 120 g. of $MgCl_2$ in a liter. This does not affect my results, but might be an obstacle to the successful repetition of my experiments by others.

Jacques Loeb.

Chicago, June 8, 1900.

NOTES ON ELECTRICAL ENGINEERING.

SUBMARINE TELEPHONY.

If waves were sent along a string stretched under water the effect of the water would be to *damp* the motion of the string causing the waves to become more and more attenuated as they travel along the string, and to *distort* the waves so that a wave initially complicated in shape would be smoothed and spread out more and more as it travels along the string.

Assuming the damping or frictional force of the water on the string at a point to be strictly proportional to the sidewise velocity of the string at that point, it can be shown that there is a certain relation between the tension of the string and its weight per unit length for which the attenuation of a wave is a minimum and for which a wave is not distorted as it travels along the string.

A submarine cable for telegraphy behaves in a manner entirely analogous to a string stretched through a viscous fluid as described above. Electrical impulses acting at one end of the cable produce electrical waves which travel along the conductor of the cable. The electrical resistance of the conductor is analogous to the frictional resistance of the water on the string, the self-inductance of the conductor is analogous to the weight of the string and the inductive capacity of the gutta-percha insulation is analogous to the tension on the string.

There is a certain relation between resistance of conductor, self-inductance of conductor, and inductive capacity of the gutta-percha covering for which electrical waves suffer minimum attenuation and no distortion as they travel along the cable. Oliver Heaviside first called attention to this condition for the *distortionless circuit*, as it is called and Dr. M. I. Pupin, in a paper read before the American Physical Society in December, showed that the distortionless condition can be realized practically by *distributed inductance* that is by connecting small coils of wire at intervals along a cable or land line.

The practical importance of the distortionless circuit is great inasmuch as such a circuit would greatly extend the possible speed of ocean telegraphy and perhaps even make ocean telephony possible.

The limit of speed of ocean telegraphy is set mainly by the distortion of the electrical impulses which pass along the cable. This distortion causes the impulses at the receiving end to overlap each other greatly.

The limitation of long distance telephony is set in part by the attenuation of the electrical waves and in part by the distortion of the waves. The first makes it difficult to produce an audible effect at the distant receiver and the second so changes the character of the waves that the sound in the distant receiver becomes more or less indistinct or inarticulate, consonant sounds are especially liable to become confused in this way.

W. S. F.

NOTES ON ENGINEERING.

'CHILLED' CAST IRON FORTS.

DOCUMENTS laid before the Board of Fortification and Ordnance of the United States Army, recently, contain some interesting information regarding the applicability of one of those materials which this country has always produced in highest perfection, in the construction of coast-defences. This country, alone, employs chilled cast iron to the exclusion, practically, of all other materials in car-wheel construction and certain brands of domestic irons possess a very extraordinary combination of strength, toughness, and capacity for taking on, by 'chilling,' a hardness exceeding that of tool-steel. Our ordnance cast irons, in earlier days, were of rare quality and our irons and steels generally are unexcelled.

For some years past, the Grusonwerk of Magdeburg-Buckau has been employing chilled cast iron in the construction of shields and turrets in the coast-defence systems of European countries, practically after the plan of the American inventor, Timby, of a half-century ago and of his licensee, John Ericsson, who used the device on the 'monitors.' The 'Endicott Board,' represented by Captain Bixby, U. S. A., investigated this matter, in 1865, with the result that the system was recommended and the erection of 22 such turrets was advised for defense of our principal harbors.

It was found that some forty turrets had been built for European governments and that probably many others, the location of which had been carefully concealed, were in existence. In the famous trial at Spezzia, an Italian turret was attacked by the shot of an Armstrong 100-ton, 16.93-inch, gun at 150 yards, the projectile weighing one ton, and withstood three such shots, each impact measuring 47,566 foot-tons. They have since been erected and accepted by a number of the European governments for defence of particularly important points. Germany has ten or a dozen.

In this country, notwithstanding our special advantage in quality of iron suited to this purpose, the general indifference of Congress and the people respecting coast-defence up to the outbreak of our recent war prevented any action being taken toward introduction of this later Timby turret, the Gruson chilled iron construction. In 1898, however, in the midst of the excitement and anxiety awakened by the rumors of a possible descent of the enemy upon our coasts, Mr. P. H. Griffin, of Buffalo, a well-known and expert manufacturer of chilled iron wheels, and other constructions, privately negotiated with the Krupps, who had by this time assumed control of the Gruson invention, and secured the right to build in this country and was given possession of the various special secret and expert methods which had made the Grusonwerk successful. A company was formed in the United States, and it is, as we are informed, now established in new works at Chester, Pennsylvania. This remarkable and important manufacture is thus finally brought into a country in which it is known that the finest material in the world is available for its purposes. *

The satisfactory chilling of cast iron to a depth of a fraction of an inch and on the surfaces of small masses, like car-wheels, has not been always found an easy matter; the production of the chill required for ordnance purposes on the surfaces of masses weighing from four to six millions of pounds involves, undoubtedly, some peculiar and difficult manipulations. Should it prove as successful, however, as with our car-wheels, another important addition will be made to the list of benefits conferred, by the metallurgical chemist and the foundryman together, upon our industrial system. This constitutes one of the most remarkable scientific achievements of the time.

THE 'AIR-SPLITTING TRAIN.'

THE daily press of recent dates has been supplied from Baltimore with interesting and impressive accounts of the repetition of the Bessemer experiment with what is now denominated the 'air-splitting train,' a train which is given, as far as practicable, the form of a cigar in its outer shape and which thus evades to some extent the head-resistance of the air and the friction of irregular surfaces on the side of the train and at its junctions between adjacent cars.

*See paper by Mr. T. Guilford Smith, 'Gruson Rotating Turret.' *Trans. Am. Inst. Min. Eng.*, Feb. 1900.

This plan was adopted by Sir Henry Bessemer, a half century ago, and with, as he thought, excellent results; but no one knows precisely to what extent the reduction of resistance occurs. The Bessemer train seems to have been a more perfect illustration of the principle of construction proposed than is the modern example.

A speed of 78 miles an hour is reported from Baltimore; but this is, of course, little to the purpose. The same weight of train could probably have been forced up to the same speed by a plucky engineer if constructed in the usual way. In fact, speeds of equal and greater magnitude are, and have for years been, made on the East and West Coast Railways of Great Britain and the record is held in our own country at above 100 miles an hour with the common form of train. What is wanted is an accurate comparison, by experts, of resistances at equal speeds of the ordinary train and of the same size and weight of train encased with the cigar-shaped shell devised by Bessemer. Obviously, the more perfectly the cylindrical spindle is approached in the exterior conformation of the train, the less will be the air-resistance. This, at high speeds now coming to be not unusual, will no doubt prove of real value if the improvement of Bessemer can be effected without too much loss of comfort, convenience and safety. Bessemer fitted his engine with a conoidal 'bow,' as the seaman would call it, and also coned the rear of the train, as well as providing against breaks between adjacent cars. The train was fairly cylindrical. He ran it at enormous speeds, for the time, until it was finally 'ditched.'

R. H. Thurston.

CURRENT NOTES ON PHYSIOGRAPHY.

TOPOGRAPHIC TERMS.

H. M. Wilson, of the U. S. Geological Survey, has compiled a very useful 'Dictionary of Topographic Forms' (*Bull. Amer. Geogr. Soc.*, xxxii, 1900, 32–41), containing definitions of some 260 words, and 'intended to include all those terms employed popularly or technically in the United States to designate the component parts of the surface of the earth.' Besides a majority of English words, there are many taken from Spanish and French, and a few from other languages, making an interesting and characteristic polyglot vocabulary that has naturally grown up in different parts of the country. The definitions are terse and appropriate in nearly all cases. Escarpment is very properly limited to 'an extended line of cliffs or bluffs,' instead of being allowed to include the body of an unsymmetrical ridge, as is the practice of some English writers. Interfluve is of relatively new coinage, equivalent to doab of northern India, meaning 'the upland separating two streams having approximately parallel course.' The printer seems to have suppressed a few words, such as 'the low alluvial land about,' at the beginning of the definition of delta which reads 'the mouth of a river which is divided down stream into several distributaries.' Bottom, as well as bottom land, should be defined according to its use in the Southern States, as a narrow flood plain. Cascade is not 'a short, rocky declivity in a stream bed,' but the dashing water on such a declivity. Upland might advisedly be used for surfaces intermediate in altitude between lowland and highland, instead of serving as a synonym for highland. Landslide deserves definition in the active sense of a sliding mass, as well as in the passive sense of a mass that has slid. Several words have a more general use than is indicated; for example, dome and meadow are well known in the east as well as in the west. Malpais is perhaps by accident referred to French instead of to Spanish origin.

It is to be hoped that geographers in different parts of the country may contribute supplements to this fundamental list, and that it may be republished in more extended form in a year or two. Adjectives and perhaps verbs also might then be added to the nouns that now appear alone. The following terms are offered for consideration, some being taken from Whitney's 'Names and Places' (1888):—Slough, towhead, ford, reach (used in Wilson's definitions, but not defined), meander, bend (perhaps kink also, from Alaska), narrows, shut-in (Mo.), dismal (N. C.), barrens (Tenn.), glen (N. Y.), intervale (N. H.), falls (in the Maryland sense of a cascading stream), river (in the Florida sense of a

'long-shore lagoon), banks (in the N. C. sense of a sand reef, and also in the fisherman's sense of fishing grounds on a shallow sea floor) whaleback and horseback (Me.). The list might be extended still further.

MORAINES OF SOUTH DAKOTA.

THE account of the 'Moraines of southeastern South Dakota and their attendant deposits' by Todd (U. S. Geol. Surv., Bull. 158, 1899) is another example of those remarkable correlations between glacial action and existing topography by which so much light has been thrown on modern physiographic study in recent years. The outer (Altamont) moraine marks the border of an irregularly lobate glacier lying between Missouri and Big Sioux rivers, whose advance was retarded where preglacial hills (outliers of Cretaceous and Tertiary strata) stood in its way; here the moraine rises in an interlobate upland which terminates inward (towards the glaciated area) in a strong cusp, as in Turtle and Turkey hills; the rim of the upland is incised by broad channels of glacial waters which flowed from the ice, and the axis of the upland is trenched by the trunk stream that resulted from the confluence of these ice-water branches. The broad lobate glacier seems to have invaded the preglacial course of the Missouri, which therefore rose as a lake (Old Red lake) just above the entrance of White river from the western plains; the lake level being recorded by a large delta built by this river. The outlet of the lake was along the southwestern margin of the ice where a new channel has been cut from the mouth of White river to that of Niobrara river. At a later stage, a second moraine (Gary) was formed around a reduced ice lobe, whose area is roughly marked by the space between the James and Vermillion rivers. The floor of the ice lobes is now a smoothly undulating plain of till or silt, free from buttes and incised by narrow stream channels.

BULLETIN OF THE AMERICAN BUREAU OF GEOGRAPHY.

E. M. LEHNERTS, of the State Normal School, Winona, Minn., with nine associate editors, has lately issued the first number of a quarterly bulletin with the above title, as an aid to the teaching of school geography. A report of a committee on lantern slides, illustrated with small prints of thirty views, is the most original feature of the issue, which is otherwise largely occupied with general articles on time-honored subjects. Four writers treat of the 'Educational value of geography,' 'What to teach in geography,' 'Geography as a basis for correlation' and 'Concrete geography.' Physiography has four articles by Collie, Tarr, Kümmel and Moore, containing some specific suggestions regarding equipment and some illustrative examples, along with generalities. An article on a special topic, the 'Points of the Compass,' is at fault in neglecting the sun's noon culmination as the simplest means of determining the local meridian and the cardinal points, and in asserting that "the north star is thus the only satisfactory, because the only fundamental starting point for determining direction." A committee on exchange of products, with Philip Emerson of Lynn, Mass., as chairman, promises to be a practical aid to isolated teachers.

W. M. DAVIS.

THE STUDY OF ELECTRICAL PRESSURE.

PROFESSOR JOHN TROWBRIDGE, of Harvard University, contributes the following account of his work on electricity to the *Harvard Graduate Magazine:*

The remarkable development of the practical employment of electrical phenomena has put physical laboratories at a certain disadvantage; for the electrical engineer and the assistants in the great electrical companies have it in their power to experiment with electrical currents of far greater strength than it is possible to obtain in a university laboratory. While the college professor might perhaps employ a hundred horse-power and its equivalent in electrical energy, the electrical engineer has at his command many thousand horse-power. He can study the effect of tremendous currents in breaking up chemical compounds and in forming new compounds. He can investigate the phenomena of electro-magnetism on a great scale. There is, however, one field in which the college professor can enter the electrical field on more than equal terms as regards

practical resources with the electrical engineer. This field is that of great electro-motive force, and I, therefore, thinking that it is important at this stage of the development of electricity to take advantage of the many practical improvements in dynamos and electrical circuits for the furtherance of the study of electrical pressure, have had installed in the Laboratory the most powerful apparatus for this purpose in the world.

The plant consists of 20,000 storage cells giving 40,000 volts or electrical units of pressure; and this can be augmented to 3,000,000 volts. In the construction of this powerful plant it was found that this limit of 3,000,000 of volts could not be exceeded as long as the apparatus is situated in a building, for the inductive action of the walls and the floors is so great that a serious loss results. In order to obtain the full effect of 3,000,000 volts the apparatus should be placed in the center of Holmes field and should be raised at least thirty feet from the ground. This great electrical plant opens a wide field of scientific inquiry. It enables one to study by spectrum analysis the effect of intense heat on gases and the vapor of metals; for by means of this battery one can produce the highest degree of instantaneous temperature yet attained. I am at present investigating the spectrum of hydrogen in the hope of obtaining some clue to the conditions of temperature in the stars. The plant also furnishes the ideal method of producing the X-rays. A Crookes can be made to glow with perfectly steady light giving out the X-rays with intense brilliancy and afford strong contrasts which have long been desired. For surgical purposes a steady source of these rays is of the utmost importance. All the methods in present use produce the rays by a more or less fluctuating process, whereas the method I have adopted is by the use of a steady current of electricity from a battery constantly in one direction. This current can be regulated to any desired degree. The result has never been accomplished before.

The interesting fact that a steady current at 40,000 units of pressure or volts is so efficient in producing the X-rays leads me to believe that a plant similar to the one in the Jefferson Physical Laboratory, but of much smaller dimensions—having the same number of cells but smaller ones—may be a desirable adjunct to a great hospital.

THE NEW YORK STATE COLLEGE OF FORESTRY.

The College of Forestry of Cornell University has made provision, as has been already stated in this Journal, for a course of lectures on 'Fish and Game Protection and Fish Culture' as a regular part of the curriculum, and Dr. Barton W. Evermann, Ichthyologist of the U. S. Fish Commission, has been selected as special lecturer to give the course. The instruction will consist of laboratory work and field excursions, together with lectures upon the life-histories of food and game fishes, their artificial propagation and protection; the relation of the forests to the streams and lakes and their inhabitants; the proper care of streams and lakes with reference to forestry, logging, lumbering, milling, mining and irrigation operations; and the value and protection of the mammals and birds of the forest.

Dr. B. E. Fernow, the Director of College of Forestry, properly considers that the forester should know not only how to care for the forest proper, but that he should understand that the protection of the denizens of the forest and the streams and lakes within the forest, and their inhabitants, also, constitute a legitimate and important part of his work.

The graduates of the College of Forestry are the men who will be called to the management of the National Forest reservations and the large private forest properties, and it is gratifying to know that they will enter upon their work with the broad and rational view of their duties and their opportunities.

This course was first given to the juniors and seniors of the present year at Axton, N. Y. (where the State College Forest is located) during the second and third weeks in May. Hereafter the course will be considerably lengthened in time and made more comprehensive in character.

Dr. Fernow will receive the thanks and congratulations of all persons interested in the preservation of our forests and the protection of the inhabitants of the forest and the forest

waters for the successful inauguration of this interesting and important phase of forestry instruction.

The value of the extensive timber investigations planned and carried on by Dr. Fernow, when Chief of the Division of Forestry, U. S. Department of Agriculture, is more and more appreciated by practitioners and investigators, as the results become better known. One of the important results was the discovery of the relation between the strength of a beam and of a column of the same material, which was deduced and mathematically developed by F. E. Neely, C.E., from the many thousand tests made on comparable material during the extended general test series.

This winter, Professor C. A. Martin and Mr. George Young, Jr., both of the College of Architecture, Cornell University, have, under the auspices of Professor F. Roth, of the New York State College of Forestry, in connection with the course on Timber physics, carried on a series of tests, published in *Engineering News*, that furnish experimental proof of the correctness of this relation, which is that the strength of a beam at the elastic limit is equal to the strength of the material in endwise compression.

In other words, if we wish to know what load a beam will carry without injury to its elastic properties, we only need to test the material in compression to failure; the load which accomplishes the failure is also the extreme load for a beam strained to the elastic limit.

The practical value of this discovery is readily seen: A simple test in compression gives, without the introduction of difficult formulæ, immediate answer to the practically important question of the beam strength to safe limits.

The tests also remove any doubt as to whether wood possesses a definite elastic limit, which, although less pronounced than in metals, is, nevertheless, readily recognized.

THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

THE issue of *Nature* for June 14th contains an article by Mr. Ramsden Bacchus giving an account of the plans for the Bradford meeting of the British Association from which we take the following particulars:

The meeting promises to be an unusually large and important one. Bradford being midway between London and Edinburgh, serves as a common meeting ground for scientific men from the south of England and from Scotland and Ireland, and it is within easy reach of the Midland and Northern University Colleges. Bradford and Leeds are so close together that for such a purpose as this they are almost one city, and the Bradford Committee, therefore, have the advantage of the Yorkshire College being practically on the spot. The last meeting of the British Association in Bradford was held in 1873, but since that time the city (which, by the way, was then only a town) has practically been rebuilt, and has grown and developed in a manner resembling the progress of an American rather than that of an English town.

It is probable that the number of visitors will be far above the average; already some sixty or seventy Fellows of the Royal Society have announced their intention of being present, and professors and eminent lecturers from nearly every university in England, Scotland and Ireland have promised to attend. The Church will be represented by the bishop of Ripon, the legal profession by the Master of the Rolls and Lord McLaren, and the names of over a score of members of both Houses of Parliament have been sent in.

The meeting will commence on Wednesday, September 5th, when the new President, Professor Sir Wm. Turner, of Edinburgh, will deliver his address in St. George's Hall. On the following evening the Mayor of Bradford will give a conversazione in St. George's Hall, at which it is hoped there will be exhibits illustrating the most recent scientific work. On Friday evening the lecture will be delivered in St. George's Hall by Professor Gotch, F.R.S., on 'Animal Electricity.' The lecture to artisans on Saturday will be given by Professor Silvanus Thompson, F.R.S., and it is expected that there will be an audience in St. George's Hall of 4000 to 5000 working men. On Monday afternoon the Mayor and Corporation will give a garden-party in Lister Park, and in the even-

ing an address will be given by Professor W. Stroud on 'Range-Finders.' The Mayor and Corporation will give another large conversazione on Tuesday evening, and on the Wednesday evening a concert will take place in St. George's Hall with the Permanent Orchestra and the Festival Choral Society, under the conductorship of Mr. Fredk. Cowan.

During the week there will be a textile exhibition at the Technical College, which will illustrate the various processes of the local industries, and the machinery employed can be seen in motion. There will be a reception at the College on Thursday afternoon, September 6th, and the smoking concert in honor of the President will also be given at the Technical College, after Professor Gotch's lecture on Friday.

Excursions to places of interest in the neighborhood will be made on Saturday, the 8th, and on Thursday, the 13th; among the places selected are Bolton Priory, Ripon and Fountains Abbey, Malham, Clapham and Ingleton, the Nidd Valley, Farnley Hall, Haworth, Ilkley, Knaresboro' and Harrogate. In addition to a number of smaller guides to the places to which excursions are to be made, the usual guide book will be provided by the Publications Committee. This book will be divided mainly into three sections. The first will deal with the history of Bradford and the development of the Bradford trade, the second section with the Bradford industries and institutions, and the third part, which is under the sectional editorship of Mr. J. E. Wilson, will deal with the scientific material of the locality, the flora, fauna, geology, meteorology, climate and public health. There will be in addition a number of pages devoted to the topography of the district, for which Mr. J. H. Hastings is responsible.

SCIENTIFIC NOTES AND NEWS.

On June 12th and 13th the delegates to the conference on the International Catalogue of Scientific Literature met in the rooms of the Royal Society, London.

The American Academy of Arts and Sciences has elected Sir Archibald Geikie, F.R.S., an honorary foreign member in the place of the late Carl Friedrich Rammelsberg.

Professor Charles F. Chandler, of Columbia University, and Professor J. Mark Baldwin, of Princeton University, have been given by Oxford University its newly created D.Sc. degree.

The degree of doctor of engineering has been conferred on Mr. J. Elfreth Watkins, of the U. S. National Museum, by the Stevens Institute of Technology, in recognition of his long and valuable studies in the history of the development of railroad engineering in the United States.

At the last meeting of the Royal Society of Edinburgh, according to *Nature*, the following were elected as British Honorary Fellows: Dr. Edward Caird, master of Balliol College, Oxford; Dr. David Ferrier, professor of neuropathology, King's College, London; Dr. G. F. Fitzgerald, professor of natural and experimental philosophy, Trinity College, Dublin; Dr. Andrew Russell Forsyth, Sadlerian professor of pure mathematics in the University of Cambridge; Dr. Archibald Liversidge, professor of chemistry in the University of Sydney; Dr. T. E. Thorpe, principal of the Government Laboratories, London; and, as Foreign Honorary Fellows: Dr. Arthur Auwers, secretary, Royal Prussian Academy of Sciences; Professor Wilhelm His, Leipzig; and Professor Adolf Ritter von Baeyer, Munich.

Dr. S. Gabriel has been appointed assistant director in the newly built chemical laboratory of the University of Berlin.

The managers of the Royal Institution, London, on the occasion of the retirement from office of the honorary secretary, passed a unanimous resolution to place on permanent record an expression of their high appreciation of the admirable way in which he has performed the duties of that office, and of his signal services to the Institution generally.

The formal opening by Lord Lister of the new clinical laboratories at the Westminister Hospital took place on June 12th. Among those present were Sir John Wolfe Barry, Chairman of the House Committee, Lord Kelvin, Dr. Church, the President of the Royal College of

Physicians, Sir William MacCormac, the President of the Royal College of Surgeons; Sir John Burdon Sanderson, Bart., Sir Michael Foster, K.C.B., M.P., and Sir Joseph Fayrer, Bart, K.C.S.I.

WE learn from the Philadelphia *Medical Journal* that Dr. W. W. Keen has raised a $50,000 library fund for the College of Physicians of that city.

MR. J. S. BUDGETT has been awarded a grant of £50 from the Balfour Fund of Cambridge University to aid him in his zoological researches.

PROFESSOR W. B. CLARK, of the Johns Hopkins University has been appointed by the Governor of Maryland, Commissioner on behalf of the State of Maryland to act with a similar Commissioner on behalf of the State of Pennsylvania and the Superintendent of the U. S. Coast and Geodetic Survey in the reëstablishment of the old historic Mason and Dixon line, in part forming the boundary between Maryland and Pennsylvania. This famous line, so long regarded as the boundary between the north and south was run by two English surveyors, Mason and Dixon, between the years 1764–68, and was marked throughout its eastern portion by granite monuments brought from England that had cut on their southern faces the arms of Lord Baltimore and on the northern the arms of the Penns. It was by far the most extensive engineering work of colonial days. The old line is now very obscure because of the destruction of many of the monuments and property interests are suffering as the result. It is the purpose of the new Survey to redetermine and properly remark the old line.

THE Director of the United States Geological Survey, says the New Haven correspondent of the New York *Evening Post*, has placed Professor H. S. Williams, of Yale University, in charge of the mapping, areal geology and preparation of the geological folios of the middle section of Connecticut, including the topographical sheets of Granby, Hartford, Meriden, Middletown, New Haven, and Guilford. Those west of the seventy-third meridian are already under way, in charge of Professor Hobbs, of Wisconsin University. Dr. H. E. Gregory, assistant to Professor Williams, has done the field work on the crystalline rocks of the Granby and Middletown sheets, and will work during the summer on the crystallines of the Meriden sheet, and the triassic areas of the Connecticut valley in general. The triassic and crystalline work will probably be finished this year. The region to be covered is an exceedingly interesting one in this State, with its volcanic remnants, dikes, terraces, pot-holes and glacial boulders, and moraines in the area already partly covered by the investigations of Dana.

AFTER thirty-seven years' service as secretary to the Paleontographical Society (London) the Rev. Thos. Wittshire has retired from that office. The present position of this Society is mainly due to the influence of Mr. Wittshire, as was recognized some time ago by those of his admirers and others who presented him with a testimonial in the form of his own portrait in oils. The council has requested Dr. A. Smith Woodward, of the British Museum, to join the Society for the purpose of taking over the secretarial and editorial duties. It is no doubt hoped that Dr. Smith Woodward's eminence as a paleontologist and experience as a writer will attract to the Society the numerous British paleontologists who have hitherto manifested their interest in its good work by criticism unaccompanied by subscriptions. He will have no easy task to please all critics: those who stigmatize as 'paving-stone paleontology' the descriptions of local faunas by enthusiasts who are anything but zoological specialists; and those whose lack of patience (or other quality) does not permit them to master the elaborate zoological investigations of restricted groups of fossils, and whose love of ease sets them in opposition to new conceptions and the new language in which they are perforce expressed.

Nature states that the president of the British Board of Education has approved of a committee, which is now sitting, "to inquire into the organization and staff of the Geological Survey and Museum of Practical Geology; to report on the progress of the Survey since 1881; to suggest the changes in staff and arrange-

ments necessary for bringing the Survey in its more general features to a speedy and satisfactory termination, having regard especially to its economic importance; and, further, to report on the desirability, or otherwise, of transferring the Survey to another public department." The members of the committee are: The Right Hon. J. L. Wharton, M.P. (chairman), Mr. Stephen E. Spring Rice, C.B., Mr. T. H. Elliott, C.B., General Festing, C.B., Dr. H. F. Parsons, Mr. W. T. Blanford, F.R.S., and Professor C. Lapworth, F.R.S., with Mr. A. E. Cooper as secretary.

At a meeting of the Board of University Studies of the Johns Hopkins University held May 23, 1900, the following minute in regard to the death of Professor Thomas Craig was unanimously adopted:

"The members of the Board of University Studies of the Johns Hopkins University desire to express their sorrow at the death of their friend and colleague, Professor Thomas Craig, who, as student and teacher of mathematics, had been connected with the University for nearly the entire period of its existence. One of the brilliant young men whom Professor Sylvester attracted to the University in its early days he won straightway the favorable notice of that eminent man for the enthusiasm and intellectual acumen with which he entered upon the study of advanced mathematics, then almost an unknown science in this country; and this fortunate combination of interest, energy, and ability characterized his entire career. At the time of his death he was occupied in the preparation of a treatise on the Theory of Surfaces. Undoubtedly the intense ardor with which he engaged in this work contributed in large measure to that impairment of the nervous system from which he had recently suffered. Professor Craig possessed great power of research, and wrote much for various mathematical journals. For many years he was editor of the *American Journal of Mathematics*, and it is largely due to his zeal and able direction that that Journal continues to hold its high rank in the mathematical world. Professor Craig occupied a place in the very front rank of American mathematicians. His scientific ideals were the highest, and as teacher, editor, and investigator, he brought to his work a high degree of originality, and an intellectual ardor which was a source of inspiration to all with whom he was closely associated."

Walter Percy Sladen, formerly zoological secretary of the Linnean Society of London, died at Florence on June 11th. Mr. Sladen wrote the Report on the Asteroida dredged by the *Challenger*, and numerous papers on recent fossil Echinoderms. A monograph by him on the British Cretaceous Asteroidea was in course of publication by the Paleontographical Society. Some years ago Mr. Sladen had an attack of the so-called influenza, and the effects of that combined with the cares of an estate to which he recently succeeded, checked his activity as a zoologist. One of his last pieces of work was the revision of the sections on star fish, and sea urchins in Dr. Eastman's edition of Zittel's 'Paleontology.' His British colleagues will miss not only a leader in a difficult branch of zoology, but a genial personality.

We regret also to record the death of Professor Mortiz Löw, Chief of Division in the Geodetic Institute of Potsdam and of Dr. Julius Althaus the well known physician and neurologist.

We learn from *Nature* that a meeting was held at the Meteorological Society on May 31st to consider the question of a memorial of the late Mr. G. J. Symons, F.R.S. It was resolved that the memorial should take the form of a gold medal, to be awarded from time to time by the Council of the Royal Meteorological Society for distinguished work in connection with meteorological science. An executive committee was appointed to take the necessary steps to raise a fund for this purpose. Contributions will be received by the Assistant Secretary, Mr. W. Marriott.

Dr. Donaldson Smith has returned to London from his journey across the unexplored tract of country between Lake Rudolph and the White Nile. The London correspondent of the New York *Evening Post* states that he was the first white man to reach the river, approaching it from the Somali coast, and travelling almost due west. He started on the 1st of August, 1899, and reached Fort Berkeley, near Lado, on the 17th of March, 1900. Dr. Smith says that he came through almost entirely unmolested by natives; had no occasion to fire a shot in self-defence, and lost only two men out of the small force of eighteen Goorkhas who formed his escort, this being the first time ex-

soldiers of the Indian army have accompanied an expedition of this character. On reaching the Nile, Smith sent his men with Mr. Fraser, the naturalist, home by way of Uganda and Mombasa, while he himself stayed at the fort for six weeks, and returned with Major Peake's expedition, by way of Khartum to Cairo. In addition to important geographical observations Dr. Smith obtained a large and valuable collection of specimens of the fauna of Central Africa.

THE second meeting of the Latin-American Scientific Congress will be held at Montevideo from March 20th to March 31st, 1901. The work of the Congress will be divided among nine sections.

THE annual meeting of the Italian Botanical Society will be held at Venice on September 9th–15th, under the presidency of Sig. Sommier.

IN view of the great importance of the scientific publications of Messrs. D. Appleton & Co. we are glad to learn that plans for the reorganization of the company and for the continuance of the business have been announced by the reorganization committee, of which James G. Cameron, vice-president of the Fourth National Bank, is chairman. The valuation of the assets is placed at $3,224,787.18. The liabilities are $1,346,696.78. The plan of reorganization provides for the unifying of the title and ownership of the three business establishments into the new corporation of D. Appleton & Co. The capitalization of the new company will be negotiable gold notes, six per cent. for $1,400,000, syndicate notes for $250,000, and capital stock, $3,000,000. General creditors are to be paid 25 per cent. in cash, and 75 per cent. in the six per cent. negotiable mortgage gold notes. The preferred obligations, such as taxes, wages, interest on mortgage, royalties, etc., amounting to $176,698.78, are to be paid in full. A cash working capital of $250,000 is to be provided. It is said that Mr. William H. Appleton will be made president of the new company and Mr. James G. Cameron chairman of the board of directors.

MR. P. STRICKLAND, United States Consul, writes from Gorée Dakar, under date of May 1st, that an exposition has just been held at Dakar which was of interest, as it was probably the first of its kind in the colony, if not in intertropical Africa. The exposition was opened with ceremonies and speeches appropriate for the occasion on the 15th of March, and closed on the 14th of April. There were exhibited, among other things, the animals of the country, including ostriches; specimens of rubber, gums, nuts, and most of the other products; fish and native gear for catching it; native jewelry, some of which is very fine; hides and skins, including bird skins for mounting on hats; furniture made in the country; native woods, etc. All the objects were artistically displayed in the beautiful park at Dakar, and, in order to encourage the natives to visit it, no entrance fee was charged. The exposition was very successful. It may be noted that the government is doing everything to encourage agriculture in the colony, and has imported seeds from the rubber trees of Brazil for free distribution among those willing to plant them.

UNIVERSITY AND EDUCATIONAL NEWS.

PRESIDENT FAUNCE announced at the commencement of Brown University that the amount needed to complete the million dollar endowment fund had been subscribed. The gifts received during the week immediately preceding commencement include one of $50,000 from Mr. Frank A. Sayles, of Pawtucket, as a memorial to his mother and sister, and $25,000 from Marsden J. Perry, of Providence. Numerous smaller sums were also received, bringing the total amount up to the sum of $1,096,106.

THE reversionary interest of Harvard University, Williams College and the Public Library at Springfield, Mass., in the estate of David A. Wells will amount to about $70,000 each.

AT the commencement of Mt. Holyoke College, it was announced that the amount collected for the second endowment fund had already reached the sum of $75,000 of which $50,000 is contributed by Dr. D. K. Pearson, of Chicago. A letter was received from Mr. John Dwight, of New York, offering to give $60,000 for a memorial building to be built on the site

GENERAL LIBRARY,

of the old Dwight House. Twenty-five thousand dollars of the endowment fund has been devoted to the establishment of a chair of psychology.

THE following gifts and bequests have also been announced during the past week: Edgar C. Brackett, a member of the State Senate of New York, has given $30,000 to Cornell College, Mt. Vernon, Ia. By the will of Alexander H. McFadden, who died recently in Philadelphia, Dickinson College, Carlisle, Pa., receives $10,000. At the commencement of Smith College President Seelye announced that $32,000 had been given to the College from various sources. Ezra J. Warner, of Chicago, has added $20,000 to a previous gift of $50,000 for a science hall for Middlebury (Vt.) College.

PROFESSOR CHARLES A YOUNG, of Princeton University, delivered the commencement address before Adelbert College. His topic was 'The Unities of Time, Space, Law and Substance in the Domain of Astronomy.'

THE Board of Regents of the University of West Virginia has refused to accept the resignation of President Raymond and has passed a resolution approving the policy he has pursued in regard to the faculty and the students.

DR. HENRY WADE ROGERS has resigned the presidency of Northwestern University.

AT Smith College, Dr. Arthur H. Pierce, of Amherst, has been appointed associate professor in mental and moral science, and Ralph Barton Perry instructor in ethics and pedagogy. The following assistants have also been appointed: Miss A. Bruere in physics, Miss F. C. Smith in botany and Miss A. P. Hazen in zoology.

THE following appointments to the position of instructor have been made recently: Dr. Lawrence E. Griffin, in biology and zoology, at Adelbert College; F. W. Kaffer, in civil engineering, at Princeton University; Dr. Walter B. Cannon, in physiology, in the Harvard Medical School; C. L. Bonton, in mathematics, and Mr. E. W. Morse, in natural history, in Harvard University.

THE following degrees were conferred at the commencement of Cornell University: There were fifty-three who received A.B., forty who received Ph.B., and sixty-two who received B.S. This is the last occasion on which the two latter degrees will be conferred by the university. There were fifty-two LL.B.'s conferred, and six M.D.'s were added to the fifty-three already conferred at the Medical commencement in New York. Eight took B.S.A. (agriculture), seven D.V.M. (veterinary medicine), one (the first to receive such a degree in this country); B.S.F. (forestry), B.Arch. (architecture) was granted to ten candidates; C.E. (civil engineering) to fifty-two, and M.E. (mechanical engineering) to 100 of whom forty-three had specialized in electrical engineering. Fourteen were then given the degree of A.M., one of M.C.E., four of M.M.E. There were nineteen candidates for the Ph.D. degree of which thirteen were in the sciences as follows: William Chandler Bagley (psychology), Charles Edward Brewer (chemistry), Kary Cadmus Davis (botany), Stevenson Whitcomb Fletcher (horticulture), Charles Tobias Knipp (physics), Gertrude Sharb Martin (social science), William Fairfield Mercer (entomology), Wilhelm Miller (horticulture), Vida Frank Moore (ethics), Edward Charles Murphy (civil engineering), William Alphonso Murrill (botany), Guy Montrose Whipple (psychology), and Ambrose Paré Winston (political science).

AT Cambrige University Mr. L. R. Wilberforce has been appointed university lecturer in in physics; Mr. G. F. C. Searle a university lecturer in experimental physics, and Dr. G. H. F. Nuttall university lecturer in bacteriology and preventive medicine.

THE sixteen wranglers of the Cambridge Mathematical Tripos this year are headed, says *Nature*, by Mr. J. E. Wright of Trinity, Mr. A. C. W. Aldis of Trinity Hall being second wrangler. An Indian student, Mr. Balak Ram of St. John's is fourth; and Miss W. M. Hudson of Newnham College, sister of the senior wrangler of 1898, is bracketed eighth wrangler. Miss E. Greene, also of Newnham, is equal to tenth. St. John's claims five of the wranglers, Trinity four, Clare two. In Part II., the bracketed senior wranglers of last year, Mr. Birtwistle of Pembroke, and Mr. Paranjpye of St. John's, are placed with two others in the first division of the first class.

GENERAL LIBRARY,
UNIV. OF MICH.
JUN 30 1900

SCIENCE

NEW SERIES.
VOL. XI. No. 287.

FRIDAY, JUNE 29, 1900.

SINGLE COPIES, 15 CTS.
ANNUAL SUBSCRIPTION, $5.00.

Chemicals and Chemical Apparatus

SOLE AGENTS FOR

SCHMIDT & HAENSCH'S POLARISCOPES

FOR SUGAR AND URINE ANALYSIS

SOLE AGENTS FOR

ZEISS' MICROSCOPES, BLOOD COUNTING APPARATUS, ETC.

KOCH'S INCUBATOR

NEW AND IMPROVED FORM, TO WORK WITH A PETROLEUM LAMP. INDISPENSABLE WHERE GAS IS NOT AVAILABLE

Furnished in Four Different Styles and Sizes from $25.00 upwards

EIMER & AMEND, New York

IT IS WORTH WHILE TO KEEP IT CLOSE AT HAND
AND TO USE IT AS OFTEN AS THE DICTIONARY.

CYCLOPEDIA OF AMERICAN HORTICULTURE

By L. H. BAILEY, Cornell University, assisted by WILLIAM MILLER, and Many Expert Cultivators and Botanists

DESCRIPTIONS OF ALL THE SPECIES OF FRUITS, VEGETABLES, FLOWERS, AND ORNAMENTAL PLANTS IN THE MARKET IN AMERICA AND CANADA.

Over 2000 Original Illustrations. Sold on Subscription for the complete set only—in four volumes. Super-royal 8vo.
Vol. I. Cloth, **$5.00** *net.*
Vol. II. *Ready Shortly.*

DIRECTIONS FOR THE CULTIVATION OF ALL KINDS OF HORTICULTURAL CROPS AND OBSERVATIONS ON MARKETING, ETC., BY PRACTICAL CULTIVATORS.

The contributors are specialists of eminence, and the work will include fully 5000 signed articles

"*This really monumental performance* is to be completed in four volumes, and judging from the first of these it will take rank as a standard in its class . . . *it is as scholarly as it is practical.* Professor BAILEY indicates the hope that it may be made the foundation of further and better studies. Our own conviction is that while the future may bring forth amplified editions of the work it is unlikely that *it will ever be superseded. Recognizing its importance, the publishers have given it faultless form.*"—THE NEW YORK TRIBUNE.

Every one who has a garden, from a window-ledge to a "little place out of town," should read

THE AMATEUR'S PRACTICAL GARDEN-BOOK

CONTAINING THE SIMPLEST DIRECTIONS FOR THE GROWING OF THE COMMONEST THINGS ABOUT THE HOUSE AND GARDEN.

By C. E. HUNN, Gardener, Horticultural Dept., Cornell University, and L. H. BAILEY. **Cloth, $1.00**

"It is a pleasure to the eye, a comfort to the hand, an inspiration to the mind, and is exactly what a city man with a suburban home has long been waiting for, and now . . . **absolutely must have.**"—*The Boston Daily Advertiser.*

GARDEN-MAKING:

SUGGESTIONS FOR THE UTILIZING OF HOME GROUNDS.

By L. H. BAILEY, aided by
L. R. TAFT, F. A. WAUGH, and ERNEST WALKER.
Third Edition. $1.00

"The little book is simply packed with information, all extremely practical . . . **A more useful book of its sort we have never seen,** or one more **indispensable** to the amateur gardener."—*The Dial.*

RECENT VOLUMES IN THE RURAL SCIENCE SERIES

Send for a descriptive circular of the volumes in this and the Garden-Craft Series

RURAL WEALTH AND WELFARE

ECONOMIC PRINCIPLES ILLUSTRATED AND APPLIED IN FARM LIFE.

By GEORGE T. FAIRCHILD, LL.D.

Cloth, 16mo $1.25.

"The study of a book like this will prove invaluable to those who are endeavoring to develop liberty of thought."—THE CHURCHMAN.

THE FARMSTEAD

THE MAKING OF THE RURAL HOME, AND THE LAY-OUT OF THE FARM.

By I. P. ROBERTS, Director of the College of Agriculture, Cornell University. 138 illustrations. **$1.25**

"The striking characteristic of this book is its practical character."—BROOKLYN DAILY EAGLE.

A Prospectus will be Sent Free on Request.

Address THE MACMILLAN COMPANY, 66 Fifth Ave., New York

Scientific Reference and Text-Books

INTRODUCTION TO ZOOLOGY

A GUIDE TO THE STUDY OF ANIMALS FOR THE USE OF SECONDARY SCHOOLS. 12mo. Half leather. **$1.10** *net*

By CHARLES BENEDICT DAVENPORT, Ph.D., Assistant Professor of Zoology in the University of Chicago, Director of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, located at Cold Spring Harbor, L. I., and GERTRUDE CROTTY DAVENPORT, B.S., formerly Instructor in Zoology at the University of Kansas. With 311 Illustrations.

TEXT-BOOK OF PALÆONTOLOGY

By KARL A. VON ZITTEL, Professor of Geology and Palæontology in the University of Munich. Translated and Edited by CHARLES R. EASTMAN, Ph.D., Assistant in Palæontology in the Museum of Comparative Zoology at Harvard College, Cambridge, Mass. English Edition, Revised and Enlarged by the Author and Editor in collaboration with the following specialists: C. E. Beecher, J. M. Clarke, W. H. Dall, G. J. Hinde, A. Hyatt, J. S. Kingsley, H. A. Pilsbry, C. Schuchert, S. H. Scudder, W. P. Sladen, E. O. Ulrich, C. Wachsmuth. Volume I. With 1476 Woodcuts. 8vo. Cloth. Pp. viii + 706. Price, **$6.00** *net*

THE CALCULATIONS OF ANALYTICAL CHEMISTRY

By EDMUND H. MILLER, Ph.D,, Columbia University. Cloth. 8vo. **$1.50** *net*

The aim has been to furnish a text-book which shall give the necessary information concerning the important chemical calculations required of an analyst which every student should thoroughly understand before taking up advanced work.

THE THEORY OF ELECTROLYTIC DISSOCIATION
AND SOME OF ITS APPLICATIONS

By HARRY C. JONES, Assoc. in Physical Chemistry, Johns Hopkins University. Cloth. **$1.60** *net*

It aims to give an account of the origin and significance of the later developments in Physical Chemistry. The origin and development of the theory of electrolytic dissociation are followed by an examination of the important lines of evidence bearing on the theory, and by a few applications in chemistry, physics and biology.

THE RISE AND DEVELOPMENT OF THE LIQUEFACTION OF GASES

By WILLETT L. HARDIN, Ph.D., University of Pennsylvania. Cloth. **$1.50**

The object of this book is to give to the reader a complete popular history of the liquefaction of air and other gases. The method of liquefying air is fully illustrated and its future possibilities briefly discussed.

"In preparing this book **the author has performed a service to the many interested** in the history of the liquefaction of gases, in its present development, and also in the possibilities for the future, a topic somewhat imaginatively treated by the public press. . . . This volume **should be read by a wide circle of readers.**"—AMERICAN JOURNAL OF SCIENCE.

Columbia University Biological Series

THE CELL IN DEVELOPMENT AND INHERITANCE

By EDMUND B. WILSON, Ph.D., Professor of Zoology, Columbia University. Second Edition, Revised and Enlarged. 8vo. Cloth. **$3.50** *net*

New Publications of the Cambridge University Press

ZOOLOGICAL RESULTS

Based on Material from New Britain, New Guinea, Loyalty Islands, and Elsewhere, collected during the Years 1895, 1896, and 1897. By ARTHUR WILLEY, D.Sc. Lond., Hon. M.A. Cantab. Lecturer on Biology in Guy's Hospital, London. Part IV. (May, 1900).
4to. Boards. **$4.50** *net*
Previously issued. Parts I.–III.
Each, **$3.50** *net*

PAPERS ON MECHANICAL AND PHYSICAL SUBJECTS

By OSBORNE REYNOLDS, F.R.S., Mem. Inst. C.E., LL. D., Professor of Engineering in the Owens College, and Hon. Fellow of Queen's College, Cambridge. Reprinted from various Transactions and Journals. Vol. I. 1869–1882.
Large 8vo. Cloth. **$5.00** *net.*

ÆTHER AND MATTER

A DEVELOPMENT OF THE DYNAMICAL RELATIONS OF THE ÆTHER TO MATERIAL SYSTEMS ON THE BASIS OF THE ATOMIC CONSTITUTION OF MATTER. Including a Discussion of the Influence of the Earth's Motion on Optical Phenomena. Being an Adams Prize Essay in the University of Cambridge. By JOSEPH LARMOR, M.A., F.R.S., Fellow of St. John's College, Cambridge. 8vo. Cloth. **$2.75** *net*

Send for our Complete Catalogue or New Announcement List.

THE MACMILLAN COMPANY, 66 Fifth Ave., New York

The Cliff-Dwellers and Pueblos

By STEPHEN DENISON PEET, Ph.D.

Editor of the American Antiquarian. Author of "The Mound-Builders, Their Works and Relics," "Animal Effigies and Emblematic Mounds," "Aboriginal Religions," and other works.

400 Pages, Finely Illustrated. Retail Price, $4.00.

This book treats of that mysterious people called the Cliff Dwellers, as allied to the Pueblos, who are supposed to be their survivors. It begins with the description of the Great Plateau and its varied scenery, the Grand Canyon of the Colorado coming in as a very important part. The "age" of the Cliff-Dwellers is also spoken of, and their distinctive peculiarities are brought out. Two or three chapters are given to an account of their discovery: First, by the Spaniards; next, by the early American explorers, and later on by the various expeditions which entered the region.

The descriptions of the Cliff-Houses are very graphic and are illustrated by many plates and small cuts, which present to the eye, the wonderful architecture and the strange situation of these Cliff-Dwellings including the towers, estufas or temples, cliff-houses, store-rooms, balconies, courts and various apartments. A comparison is drawn between the Cliff-Dwellings and the different kinds of Pueblos which are still standing—some of them in ruins.

The book covers the whole field, and describes nearly all of the structures that have been discovered. The customs of the present Pueblo Tribes are also described, especially the Snake Dance, which has become so celebrated, and several cuts are given in illustration. No other book has ever been published which is so comprehensive. It is likely to be the standard work for many years to come.

Address: THE AMERICAN ANTIQUARIAN,
5817 Madison Ave., Chicago.

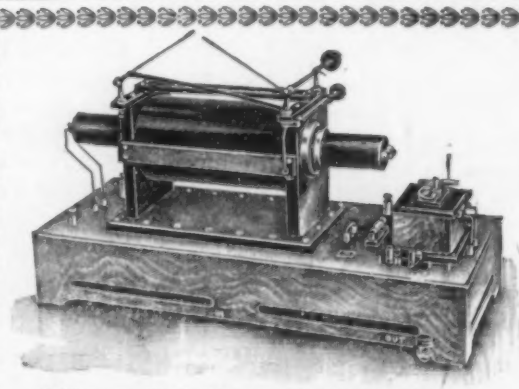
Imparts Energy

Horsford's Acid Phosphate

The most agreeable and effective remedy for relieving Languor and Exhaustion, so common in the spring and summer months. Its nutrient and tonic effects give tone and vigor to the entire system.

Taken before retiring it quiets the nerves and induces refreshing sleep.

For sale by Druggists.



Willyoung 8" to 15"–110 Volt X-Ray Machine.

TAKE NOTICE

AFTER VACATION comes the FALL WORK, you will need Apparatus then. DON'T WAIT BUT PLACE YOUR ORDERS NOW FOR FALL DELIVERY. You will get your goods in time, SAVE MONEY, and enable us to arrange our summer work and hold our trained force together.

Send your list now and get our quotations.

WE MAKE A LARGE LINE OF SCIENTIFIC INSTRUMENTS OF PRECISION, MAINLY ELECTRICAL INCLUDING GALVANOMETERS, STANDARDS OF RESISTANCE, PHOTOMETERS, ELECTROMETERS, OSCILLOGRAPHS, ETC.

Repairs to all kinds of Instruments. Resistances readjusted in INTERNATIONAL OHMS.

CATALOGUE W--175 pages, free on application.

ELMER G. WILLYOUNG (Formerly Willyoung & Co., Philadelphia, Pa.), 82-84 Fulton St., New York

A Cyclopedia of Temple Primers

May be built to meet your individual needs or taste. Each 18mo. Cloth, 40 Cents.

Latest Issue: **SOUTH AFRICA.** By W. Bazil Worsfold, Author of "The Redemption of Egypt," etc.

The Races of Mankind — By Dr. Michael Haberlandt.
Roman History — By Dr. Julius Koch.
An Introduction to Science — By Dr. Alexander Hill.
A History of Politics — By Prof. E. Jenks.
Dante — By E. G. Gardiner.
The History of Language — By Henry Sweet.
The English Church — By the Very Rev. H.D.M. Spence.
The Greek Drama — By L. D. Barnett.
The Civilization of India — By Romesh C. Dutt.

Illustrated, Complete, Inexpensive. They are in Every Way Up-to-Date.

THE MACMILLAN COMPANY, Publishers, New York.

SCIENCE.

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE.

Entered in the post-office at Lancaster, Pa., as second-class matter.

TERMS OF SUBSCRIPTION.

Five dollars annually in advance: single copies 15 cents. Subscriptions and advertisements should be sent to SCIENCE, 41 North Queen Street, Lancaster, Pa., or 66 Fifth Avenue, New York.

The first three volumes of the new series can be supplied for $5.00 each, the fourth, fifth, sixth, seventh, eighth, ninth and tenth volumes for $2.50 each. The publishers will pay 20 cents each for the numbers of Feb. 15, 22, Aug. 2, 1895; Jan. 31, 1896.

Published Weekly by

THE MACMILLAN COMPANY

THE

Journal of Applied Microscopy

(MONTHLY)

$1.00 per year. **Foreign $1.25.**

The Only Publication of its Kind in English.

ORIGINAL ARTICLES

dealing only with the **PRACTICAL SIDE** of **LABORATORY** and **MICROSCOPICAL** work.

A reference work for all workers in

BIOLOGY, BOTANY, PETROGRAPHY, MEDICINE and GENERAL MICROSCOPY.

Over

ONE HUNDRED CONTRIBUTORS

representing the best Universities and Colleges.

REVIEW DEPARTMENT

strictly up to date.

General Monthly Résumé of **FOREIGN AND AMERICAN LITERATURE** bearing on Applied Microscopy.

Published by

PUBLICATION DEPARTMENT,
BAUSCH & LOMB OPTICAL CO.,
ROCHESTER, N. Y.

The Physical Review.

A JOURNAL OF EXPERIMENTAL AND THEORETICAL PHYSICS.

CONDUCTED BY

Edward L. Nichols, Ernest Merritt, and Frederick Bedell.

LIII. April, 1900.

TABLE OF CONTENTS.

The Acoustic Analysis of the Vowels from the Phonographic Record. LOUIS BEVIER, JR.

Note on the Variation of the Specific Heat of Water between 0° and 100° C. H. L. CALLENDAR and H. T BARNES.

The Magnetic Molecular Susceptibility of Salts of the Iron Group. O. LIEBNECHT and A. P. WILLS.

Gibbs' Thermodynamic Model. W. P. BOYNTON.

On the Temperature of the Acetylene Flame. EDWARD L. NICHOLS.

Note on the Law of Distribution of Velocities among Gas Molecules. N. D. C. HODGES.

New Books: *Crew:* Elements of Physics; *Watson:* Text-Book of Physics.

Annual Subscription, $5.00.

PUBLISHED FOR CORNELL UNIVERSITY

THE MACMILLAN COMPANY

66 Fifth Avenue, New York.

The International Monthly

A Magazine of Contemporary Thought

Volume One, No. 6. *June, 1900.*

SUBSCRIPTION RATES:

For One Year, $3.00. Single Nos. Twenty-Five Cents

THE MACMILLAN COMPANY announces that from January 1, 1900, it will publish in America and England a journal whose aim will be to make accessible to the general reader the progress of the several departments of knowledge. Scholars both in this country and abroad, will present it in Contemporary Thought in a *permanent, dignified, yet practically available form.*

THE INTERNATIONAL MONTHLY is under the direction of an Advisory Board composed of one person in America, representing each of the departments, who has one associate residing in France, one in England, and one in Germany. The editorial management is conducted by Mr. FREDERICK A. RICHARDSON.

THE INTERNATIONAL MONTHLY for June contains

Relation between Early Religion and Morality
EDMUND BUCKLEY, University of Chicago
Political Parties and City Government
FRANK J. GOODNOW, Columbia University
Recent Advance in Medical Science
REYNOLD W. WILCOX, New York
The Nature of the Creative Imagination..TH. RIBOT, Paris
High Explosives..Capt. E. L. ZALINSKI, U.S.A. (Retired)

THE MACMILLAN COMPANY, Publishers, N. Y.

The Macmillan Company's Good Books for Summer Reading

The most important piece of fiction issued this season.

JAMES LANE ALLEN'S NEW NOVEL—THE REIGN OF LAW

A TALE OF THE KENTUCKY HEMP FIELDS.

Ready This Week.
Illustrated.

By the author of "The Choir Invisible," "A Kentucky Cardinal," etc.

"The story has not only the extraordinary beauty which gives Mr. Allen's work a place by itself in our literature, it has also great spiritual depth and unusual grasp of thought."
—HAMILTON W. MABIE, in *The Outlook*.

Cloth, 12mo, $1.50

A FRIEND OF CÆSAR

A TALE OF THE FALL OF THE ROMAN REPUBLIC. By WILLIAM STEARNS DAVIS. Cloth, **$1.50**

"As a story . . . there can be no question of its successes . . . while the beautiful love of Cornelia and Drusus lies at the sound sweet heart of the story, to say so is to give a most meagre idea of the large sustained interest of the whole . . . There are many incidents so vivid, so brilliant that they fix themselves in the memory."—NANCY HUSTON BANKS in the current *Bookman*.

THE BANKER AND THE BEAR

THE STORY OF A CORNER IN LARD. By HENRY KITCHELL WEBSTER. Cloth, **$1.50**

A vivid picture of the possibilities of the stock market, the banking business, etc., for romance.

"There is a love affair of real charm and most novel surroundings; there is a run on the bank which is almost worth a year's growth, and there is a spy and a villain and all manner of exhilarating men and deeds, which should bring the book into high favor."—*Chicago Evening Post*.

Mr. WEBSTER is one of the authors of **THE SHORT LINE WAR.** By MERWIN-WEBSTER. Cloth, **$1.50**

"Breezy, up-to-date; . . . the best of its kind."
—SPRINGFIELD REPUBLICAN.

"A capital story of adventure in the field of railroading."—THE OUTLOOK.

By JAMES NEWTON BASKETT

Each, Cloth, $1.50

AS THE LIGHT LED

"It has been a long while since the subtle charm of field and woodland has been so satisfactorily and adequately blended with the strength and weaknesses of human nature. . . . It is this that gives the story such stirring interest."
THE NORTH AMERICAN, Phila.

AT YOU-ALL'S HOUSE

A MISSOURI NATURE STORY.

"Delightfully written with grace, color and feeling."
—LOUISVILLE TIMES.

By FLORA ANNIE STEEL

Each, Cloth, $1.50

VOICES IN THE NIGHT

A Chromatic Fantasia

ON THE FACE OF THE WATERS

A Tale of the Mutiny

Mrs. Steel is acknowledged to have no equal in presenting the life of the real India, not merely English life in India, and the *Boston Herald* justly describes her work as "most unusual not only in plot and construction, but also in keenness of insight." Its intense interest may be guessed from the twelve editions of "On the Face of the Waters" demanded in four months, in this country alone where the subjec necessarily makes a less personal appeal than in England.

Studies of City Life in New York and Chicago — *Nearly Ready*

THE BENNETT TWINS

By GRACE MARGUERITE HURD. Cloth, 12mo, **$1.50**

A picture of life in a large city studio.

THE WEB OF LIFE

By ROBERT HERRICK, author of "The Gospel of Freedom," etc. Cloth, **$1.50**

Those who care less for fiction than for nature will find charming material for a Summer in a Garden on another page, while still another contains a list of books likely to appeal to those who feel that present conditions demand some special study of every citizen. For further information address

THE MACMILLAN COMPANY, 66 Fifth Ave., New York

New Books on Political Science

JUST READY

THE ONLY BOOK ON THE CHINESE CRISIS

WORLD POLITICS. By PAUL S. REINSCH, Assistant Professor of Political Science, University of Wisconsin. *The Citizen's Library.* Half leather. **$1.25** *net.*

A famous critic says:—

"'WORLD POLITICS' gives the very best account of affairs in China I have seen. It couldn't have been better if it had been specially prepared for this crisis. The account of the present condition of the country is full, interesting, and dispassionate; the report of the concessions to the Powers and their relative claims and privileges admirable. One gets a comprehensive view of the whole situation. There is a host of people who want such a book as this."

AN OUTLINE OF POLITICAL GROWTH IN THE NINETEENTH CENTURY

By EDMUND HAMILTON SEARS, A.M., Principal of Mary Institute, Saint Louis. 8vo. Cloth. **$3.00** *net.*

"Simply, clearly, comprehensively, it summarizes the political development of every nation and every important province in the world during the present century."—THE OUTLOOK.

THE DISTRIBUTION OF WEALTH

A THEORY OF WAGES, INTEREST AND PROFITS.

By JOHN BATES CLARK, Professor of Political Economy, Columbia University; author of "The Philosophy of Wealth," etc. Cloth, 12mo. **$3.00**, *net.*

POLITICS AND ADMINISTRATION

A STUDY IN GOVERNMENT.

By FRANK J. GOODNOW, LL.D., Professor of Administrative Law in Columbia University. 12mo, Cloth, **$1.50** *net.*

DEMOCRACY AND EMPIRE

WITH STUDIES OF THEIR PSYCHOLOGICAL ECONOMIC AND MORAL FOUNDATIONS.

"The most profound and closely reasoned defense of territorial expansion that has yet appeared. . . . It is a calm, penetrating study of the trend of civilization and of our part in it, as seen in the light of history and of evolutionary philosophy."—*The Chicago Tribune.*

By FRANKLIN H. GIDDINGS, Professor of Sociology in Columbia University, author of "Principles of Sociology," etc., etc. 8vo, Cloth. **$2.50.**

INTRODUCTION TO PUBLIC FINANCE

Second Edition Revised and Enlarged.

By CARL C. PLEHN, Ph.D., Assoc. Professor in the University of California. 12mo, Cloth. **$1.60** *net.*

COLONIAL CIVIL SERVICE

THE SELECTION AND TRAINING OF COLONIAL OFFICIALS IN ENGLAND, HOLLAND AND FRANCE.

By A. LAWRENCE LOWELL, with an account of the East India College at Haileybury (1806-1857), by H. MORSE STEPHENS. 12mo, Cloth, **$1.50.**

PREVIOUS ISSUES IN

The Citizen's Library of Economics, Politics and Sociology

FIRST VOLUME.

Monopolies and Trusts

By RICHARD T. ELY, Ph.D., LL.D., University of Wisconsin. Complete and searching, interesting and authoritative.

"It is admirable. It is the soundest contribution on the subject that has appeared."—Prof. JOHN R. COMMONS.

Under the General Editorship of

RICHARD T. ELY, PH.D., LL.D.,

Director of the School of Economics, and Political Science and History; Professor of Political Economy University of Wisconsin.

Each, half leather, $1.25 *net.*

The Economics of Distribution

By JOHN A. HOBSON, author of "The War in South Africa," etc.

"Another important treatise dealing with one of the vital phases of economics . . . in a clear and effective style."

—*The Chicago Record.*

The Outlines of Economics

By Prof. RICHARD T. ELY, *Editor of the Series.*

Economic Crises

By EDWARD D. JONES, Ph.D., *Asst. Professor of Economics and Comm'l Geography, University of Wisconsin.*

THE MACMILLAN COMPANY, Publishers, New York

$4.00 Per Annum **Single Numbers $1.00**

The American Historical Review

Board of Editors

GEORGE B. ADAMS
ALBERT BUSHNELL HART
HARRY PRATT JUDSON
ANDREW C. McLAUGHLIN
WILLIAM M. SLOANE
M. MORSE STEPHENS

Managing Editor

J. FRANKLIN JAMESON

Vol. V No. 4 **JULY 1900**

ISSUED QUARTERLY

CONTENTS

GEORGE B. ADAMS	The Critical Period of English Constitutional History	643
HUBERT HALL	Chatham's Colonial Policy	659
MAX FARRAND	Territory and District	676
	The Judiciary Act of 1801	682
HOWARD L. WILSON	President Buchanan's Proposed Intervention in Mexico	687
DOCUMENTS—Letters of Ebenezer Huntington, 1774-1781		702
REVIEWS OF BOOKS—Lanciani's *The Destruction of Ancient Rome*; Hodgkin's *Italy and Her Invaders*, VII., VIII.; Smith's *The United Kingdom*; Ronciere's *Histoire de la Marine Française*, I.; Emerton's *Desiderius Eramus*; Schouler's *History of the Civil War*; Adams's *Charles Francis Adams*; Tarbell's *and* Hapgood's *Abraham Lincoln*; Wyeth's *Life of Nathan Bedford Forrest*; Blackman's, Carpenter's, Young's books on Hawaii; and other reviews		730
BIBLIOGRAPHICAL—Minutes of Abolition Conventions, 1794-1829		804
NOTES AND NEWS		806

THE MACMILLAN COMPANY,

41 North Queen St., Lancaster, Pa. 66 Fifth Avenue, New York

LONDON: MACMILLAN AND CO., Ltd.